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Design and implementation of objectives-based programs : a model and partial validation.

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DESIGN AND IMPLEMENTATION OF OBJECTIVES-BASED PROGRAMS:
A MODEL AND PARTIAL VALIDATION

A Dissertation Presented

By

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ABSTRACT

DESIGN AND IMPLEMENTATION OF OBJECTIVES-BASED PROGRAMS:
A MODEL AND PARTIAL VALIDATION

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The goal of this investigation was to demonstrate the feasibility of designing and systematically implementing objectives-based programs in education. In order to accomplish this goal the study had three purposes:

1. To extract the key elements of objectives-based programs from the relevant research and development literature.

2. To integrate the crucial elements from (1) into a model for the design and implementation of objectives-based programs.

3. To address two of the crucial elements: first, the preparation and evaluation of objectives and domain specifications, and second, the preparation of test items and assessment of their validity.

To achieve these purposes, the characteristics of three critical components of objectives-based programs, curriculum, instruction and evaluation, were examined in the research and development literature. These components were then incorporated into a model designed for the implementation of objectives-based programs. The investigation then focused on the implementation of the curriculum and evaluation components. In the curriculum component, instructional objectives were developed to define a basic elementary mathematics program in grades

three to six. This was followed by a more clear definition of the objectives by expanding them into domain specifications. In the evaluation component, items were developed from domain specifications and validated through a series of judgmental and empirical reviews and revisions. Content and instructional specialists were involved in the development, review, and revision of domain specifications and items during the implementation. In total, a basic mathematics curriculum was produced that consisted of 96 objectives, 96 domain specifications and 960 items. Following the comprehensive item review process, 936 items were found to be acceptable. The objective and item writing and review process was accomplished with the cooperation of 48 teachers, 1152 students and 5 content specialists.

The study ended with a description of what was and was not done as part of the investigation, indicated those procedures which require revision, future plans for continuation of the investigation, and suggestions for additional research. The study was viewed as successful to the extent that in the study it was demonstrated clearly that within a reasonable period of time it is possible for a modest-sized school district to carry out a project to develop and evaluate a set of objectives and test items using the most up-to-date technology and do the project in a way that is systematic and integral to the overall goals of the school district.

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CHAPTER I

OBJECTIVES-BASED PROGRAMS AND BASIC EDUCATION

1.1 Statement of the Problem

Public education is currently besieged by the demands that it demonstrate proof of its products. On the one hand there is the "back-to-basics" movement; on the other, a persistent call for minimal competency criteria for high school graduation. Educators are challenged to insure that all students demonstrate mastery of those skills deemed necessary for adult functioning in a complex society. Indeed, this is fundamental in a democratic nation. Ralph Tyler summarizes the primary goal of education in a pluralistic society:

> A young person without the competency of one who has an elementary education finds very few jobs available to him. And more than a high school education is needed for employment in the fields where demand for workers is increasing. The critical task of the school is no longer one of sorting students but rather one of educating all, or almost all, young people to meet the needs of modern society and to help them take advantage of the greater opportunities now available. (Tyler, 1976, p. 19)

The current cultural context from which the demands for basic competencies arise are diffuse and complex. Taxes continually increase, unemployment remains high, civil service jobs are cut back, and the chances for employment decrease. Against the background of zero population and declining school enrollment, staffs are cut and yet the costs of education increase and taxes continue to rise. The public challenges education with a simple question: "What are we getting for our money?" This is evidenced in the actions of more than thirty-six states which have legislated some form of competency requirements for high school graduation.

A 1977 Gallup Poll (the Ninth Annual Gallup Poll of the Public's Attitudes Toward the Public Schools, 1977) sheds light on public attitudes towards education. Of the 47% of the public school parents who responded positively to having heard of the back-to-basics movement, a total of 83% responded positively to the question: "Do you favor or oppose this back-to-basics movement?" The poll also indicated that the public regards the 3r's as basic and prefers education return to schooling of earlier years. In the same poll the rating of the public schools had dropped, but 78% of the public school parents still believe that final decision-making concerning curriculum should remain with the school board.

On the federal legislative level the democratization of education is expanding. More and more minorities are brought before the public consciousness and thrust into the mainstream through legislation for the handicapped, the indigent, the learning disabled, senior citizens, women, and the disadvantaged. Education is challenged to provide equal educational opportunities for all people.

The educational establishment can respond to these demands. An administrator reacting to a Critical Issues Survey stated: "This is our opportunity to strengthen programs and teaching strategies and, in the process students cannot help but make gains." (Neil, 1975). Is he saying that education has the resources to develop a balanced response to public pressures and legislative mandates?

Competency-based theory in the last 20 years can contribute to framing a reply rooted in the "best - tradition" yet firmly based on research investigations. Its reply would consist of the following responses:

1. Curriculum design should generate clearly defined objectives.

2. Implementation of objectives-based instruction can re-vitalize the basics.

3. Objectives-based instruction focuses on individual student performance, wherein progress is referenced to the students specific learning objectives.

4. Such instruction likewise is a viable alternative to average-based instruction which emphasizes the same objectives for all students and references a student's performance to the average performance of the group.

5. Objectives-based instruction facilitates the assessment of student performance through its utilization of carefully developed and well-defined competencies and validated assessment tasks.

6. Such assessment establishes minimum acceptable levels of student performance by referencing performance to the criterion behavior of well-defined behavioral domains.

7. Minimum acceptable levels of performance are therefore consonant with the current concern of the competency-based movement.

8. The goals of competency-based education are compatible with objectives-based instruction supported by criterion-referenced measurement.

1.2 Objectives-Based Instruction and Competency-Based Education

Objectives-based programs characteristically express intended curriculum outcomes (competencies or objectives) clearly. It is these characteristics that hold promise for competency-based education in the 3R's, mathematics, reading, and language arts. Objectives-based programs seem to be the most effective and efficient means for "guaranteeing" a basic education for most students. They are instructionally effective because characteristically, performance and assessment are thoroughly integrated with instruction. Instruction proceeds as a function of either the diagnosed needs or the assessment of student mastery. An examination of the general characteristics of objectives-based programs supports their effectiveness in fulfilling the requirements of basic education.

Objectives clarify instructional intent by specifying the outcomes of learning in observable, measurable terms. They present curriculum workers and teachers with the content and skills which are to be transformed through instruction into learning opportunities. The tasks performed by students when reacting to instructional stimuli present opportunities for teachers to observe and assess changes in learner behavior. Modification of Popham's (1975, p. 48) three major advantages for using objectives indicate their usefulness:

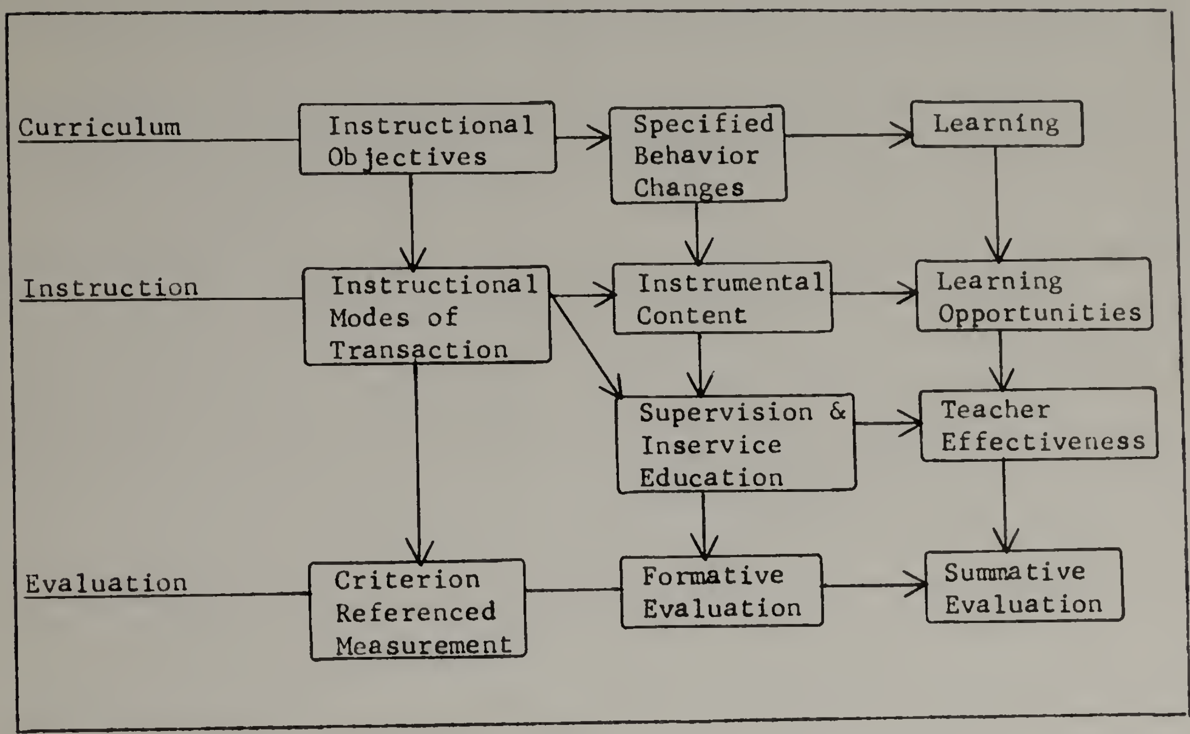
1. Curricular - clearly-defined objectives specify learning outcomes to achieve curriculum goals.

2. Instructional - clearly-defined objectives ease the development of learning opportunities directed at the achievement of goals.

3. Evaluative - clearly-defined objectives serve as a data source for assessing program worth and student learning.

The interrelationship and interdependence among curriculum, instruction, and evaluation in objectives-based programs is presented in Figure 1. The objectives are the source of the desired outcomes and the processes that mediate between them and the achievement of these outcomes. In the following chapters the curriculum, instructional, and evaluative components of objectives-based programs will be examined and their contribution to a model for the design and implementation of one such program described.

Figure 1. The interrelationship among curriculum, instruction, and evaluation



1.3 Purposes of the Study

In order for objectives-based programs to serve as a successful response to demands for competency-based education, several key elements in curriculum, instruction and evaluation must be coordinated. In this study a model will be proposed to provide the proper linkages. In addition, special emphasis will be given to the critical link between a curriculum expressed in objectives and evaluation through criterion-referenced measurement. More specifically, in order to demonstrate how an objectives-based curriculum and criterion-referenced measurement can meet the needs of competency-based education, this study was designed to accomplish three purposes:

1. To extract the key elements of objectives-based programs from the relevant research and development literature.

2. To integrate the crucial elements from (1) into a model for the design and implementation of objectives-based programs.

3. To evaluate two of the crucial elements: first the preparation of objectives and domain specifications and second the assessment of content validity through the development of a valid item pool.

The study will describe systematic implementation of the procedures, describe and document the process, report the results, and suggest revisions and further research.

1.4 Organization of the Study

The balance of this study will be reported in five chapters. Chapter II presents a review of the research on the elements common to objectives-based programs, then expands upon the characteristics presented in the first chapter.

Chapter III presents a model that incorporates and elaborates upon the elements presented in Chapter II and introduces additional elements that are considered necessary for the design and implementation of objectives-based programs. The interrelationships among the curriculum, instructional, and evaluative components will be elaborated. The preparation, review, and revision of objectives and test items will be introduced and will serve as the foundation for Chapters IV and V.

In Chapter IV the emphasis shifts from theory and models to a partial implementation of an objectives-based program. A basic elementary mathematics program served as the content area for the selection and development of objectives, their amplification into domain specifications, and their review and revision. The procedures employed will be reported in detail and documented.

In Chapter V the procedures for developing items from domain specifications, validating the items through judgmental reviews by content and instructional specialists, and the field testing of items is described, documented and illustrated.

A description of what was and was not done as part of the study, and what procedures required revision or change is reported in Chapter VI. Future developments and implementation, and suggestions for additional research on the model are presented.

CHAPTER II

CHARACTERISTICS OF OBJECTIVES-BASED PROGRAMS

2.1 Purposes

The purpose of this chapter is twofold: to review research on the major elements of objectives-based programs and its effect on student performance, and to discuss the characteristics of three components of objectives-based programs, namely, curriculum, instruction, and evaluation.

2.2 Review of Research

Research relevant to objectives-based programs can be classified into two major categories: studies dealing with the mastery model and those that investigate separate components. This section will focus on research in the latter area. However, a brief discussion follows on mastery model research to place the limitations of this study within its larger perspective.

Mastery Model Research

There is considerable material from excellent review by Melton (1978), Torshen (1977), Duchastel and Merrill (1973), and Kibler, and others (1974). Torshen has cited a minimum of fifty studies in her review and summarized them by stating:

> In sum, the research evidence available to date supports the conclusion that implementation of the six components of the mastery model contributes to higher student performance on objective-referenced measures of cognitive mastery and to increased retention, when compared with instructional programs that omit one or more of the mastery components. (Torshen, 1977)

Research that compared students in mastery model programs to those who were not demonstrated that mastery students' achieved higher levels of performance (Block, 1972; Anderson, 1973; Fiel and Okey, 1974).

Research on Separate Components

This section will review research effecting student learning in: 1) possession of objectives, 2) preassessment, 3) instruction and 4) mastery assessment.

Numerous investigations (Doty, 1968; Engel, 1968; Blaney and Mckie, 1968; Dalis, 1968; Keuter, 1970; Lawrence, 1970; Nelson, 1970; Puckett, 1971; Webb, 1971; Ferre, 1972; Olsen, 1972; Snider, 1975; Raghubir, 1979; DeBlock and others, 1980) address the effects on learning when either students or teachers are "in possession" of instructional objectives. This means that teachers utilize objectives for planning of instruction or communicate objectives prior to or during instruction. Results of this research indicate that in either of these cases students who possess objectives score higher than those who do not. Melton (1978) cites numerous researchers "who lend support to the claim that providing students with behavioral objectives enhances relevant learning". Kibler, and others (1974) likewise reported: "Three studies (Rothkopk and Kaplan, 1972; Dalis, 1970; Janecko, 1972) found that students who receive specific instructional objectives . . . . achieved significantly higher scores on a test of learning than students receiving more general objectives". This has also been found to be true when the teachers know and use objectives in their teaching (McNeil, 1969; Piat, 1970; Wittrock, 1962; McNeil, 1967; Bryant, 1971). Studies by Mager and McCann (1961), and Allen and

McDonald (1963) also found that students spent less time on learning when they knew what objectives they were studying without any decrease in achievement levels. The work of Dalis (1970) and Melton (1978) further indicates that students show significant gains when objectives are clearly stated. Torshen (1977) cites additional research on the effects of presenting students the objectives before the learning tasks:

> Rothkopf and Kaplan (1972) and Morse and Tillman (1972) found that relevant learning was greater than incidental learning when students were presented with behavioral objectives prior to the beginning of the instruction. Objectives salient to the instructional tasks were found to be most effective (Dalis, 1970; Huck and Long, 1973; Lawson, 1973). Behavioral objectives presented to students had a greater impact upon student performance in traditional types of teaching than in programmed instruction and computer-assisted instruction (Sink, 1974). (Torshen, 1977, p. 104)

It appears that the research on the "possession" of objectives makes clear the need for curriculum specialists, teachers, and students to be cognizant of and to use objectives in planning, instructing, and learning.

Preassessment

The purpose of preassessment, or placement testing, is to determine the starting points for students in a curriculum. Placement testing can provide information about a learner's status relative to learning outcomes designed in the curriculum. Yeager and Kissel (1969) compared the predictive ability of IQ to a program-based placement testing in measuring the outcome skills in a curriculum. Their results indicated that "mastery of prerequisites needed in the instruction was significantly related to their (student) learning rates".

Torshen (1977) states:

> Research available to date suggests that measures of student mastery of specific method and content prerequisite and affective entry characteristics are more effective preassessment measures than are measures of students general intellectual ability, including IQ test performance.

Anderson and Fowler (1978) also found that preassessment led to more precise instruction.

Preassessment is based on the proposition that skills and knowledge are hierarchically sequenced in a curriculum. This order of increasing complexity of learning is supported by Suppes (1974), Hunt (1961), and Brunner (1962). This view is further supported by Rosner (1972), Madaus, Woods, and Nuttall, (1973), and Gagné (1962). Richard White (1973) summarized the results of this research and has doubts about these conclusions, indicating a paucity of investigations. White (1974) performed a study to validate hierarchies, then designed an instruction program and tested it with students. He concluded:

> that general intellectual skills may be learned hierarchically, but specific individual facts are not hierarchically learned . . . . the learning of intellectual skills was predicated on mastery of lower order skills (White, 1973).

Although the research is somewhat inconclusive the implication seems to support the use of preassessment on lower order cognitive skills of the type usually addressed in a basic skills program. There is no evidence to negate the usefulness of hierarchically sequencing objectives in a curriculum.

Instruction

The selection and organization of content as described by the objectives is important for student learning. "The content selected . . . . and the emphasis given to specific aspects of the content are two significant variables affecting student learning and the educative process" (Walker and Schaffarzick, 1974). This view was corroborated by the results of the International Education Association (IEA) evaluation study. The results indicated that student performance was affected by the content they were exposed to and the time they spent in instruction (Bloom, 1974). The conclusion that exposure to content significantly affected what students learn is reinforced by the results of the National Longitudinal Study of Mathematical Abilities (Wilson, Cahen, Begle, 1968-1972). The results of these studies present another guideline for curriculum developers, namely: choose the content wisely because it may have a direct affect on what students learn. Sommerfield and Accola (1978) found that students respond to frequent feedback on progress in achieving behaviorally stated expectations.

The IEA research and the work of Wiley and Harnischfeger (1974) further indicated that student achievement is influenced by the time spent in instruction and in school, that is, the actual time students spent in active learning (Anderson, 1973). Also, studies by Labaderne (1967) and Combs (1964) demonstrated that high achieving students spent more time actively learning than their counter-parts. The reverse has been corroborated by the research that shows that low achievers take more time before getting "active" in learning activities than do high achievers (Lloyd, 1971; Sheppard and Mac Dermot, 1970; Zeaman and Hause, 1963, 1967).

Studies by Block (1971) and Arlin (1974) indicated that when students have mastered the basic or prerequisite skills they tend to make fewer errors and spend less learning time than when they are presented more complex learning tasks.

Mastery Assessment

Diagnostic assessment is the second form of testing used in most objectives-based programs. Its purpose is to assess a learner's status in relation to a subsequent unit of instruction. The results of the assessment provide teachers the information for making decisions in selecting learning opportunities appropriate to learner needs. The key issues involved in diagnostic testing are the congruence of items and objectives of the unit, test length, number of items per objective, and minimum passing levels.

Numerous researchers have investigated these issues and a variety of judgmental and empirical methods have been suggested. Block's studies (1972, 1973), for example, have indicated that cut-off scores promote higher achievement, better retention and more active learning. Further research has pointed out that by requiring students to demonstrate mastery (minimum pass levels) on diagnostic tests their performance was higher on subsequent posttests than lower scoring students (Arlin, 1974, Anderson, 1973; Block, 1972, 1973; Calhoun, 1973; Carson and Minke, 1975; Davis, 1975; Johnson and O'Neil, 1973; Semb, 1974). The studies of Block (1971), Block and Anderson (1975), Kersh (1969), and Science Research Associates (1974) have indicated that the best procedure is to provide learners with learning opportunities through materials and methods different from the original activities. Another method that proved effective was to remediate learners on prerequisites (Fiel and Okey, 1974).

2.3 Characteristics of Objectives-Based Programs

In this section the characteristics of objectives-based programs will be examined. These characteristics are gleaned from two well known programs which have reported significant improvement in student educational gains; Individually Guided Education (IGE) (Klausmeier, Rossmill, and Saily, 1977; Klausmeier (ASCD), 1977; Klausmeier, 1975; Lipham and Fruth, 1976; Wiersma and Jurs, 1976; Gronlund, 1974); and Mastery Learning (ML) (Block and Anderson, 1975; Block, 1974; Bloom, 1974; Gronlund, 1974; Block, 1977; Hambleton, 1974; Torshen, 1977). The characteristics listed below have been synthesized from the work of several authors (Briggs, 1975; Gronlund, 1974; Torshen, 1977; Talmage, 1975; Hull, 1974; Bouchard, 1974; Kibler and others, 1974). The characteristics will be categorized and reported under three program subdivisions - curriculum, instruction, and evaluation.

Quite often the terms, individualized instruction and objectives-based instruction are used interchangeably. The characteristics of one are usually true of the other. This view is reinforced by George Weber, the Associate Director of the Council for Basic Education, when in an article on individualized instruction he stated:

> the formal systems (IGE, PLAN, IPI, ML) have two major advantages. They force the school to define clearly what is to be learned and then to test carefully to see what extent it has been learned . . . .The other advantage lies in the concept of mastery (Weber, 1977).

This view is reinforced by Glen Heathers who believes that "a chief justification for individualized instruction is that it can permit every student to achieve mastery of tasks undertaken" (Heathers, 1977). One of the goals of the study is to demonstrate how, by coordinating selected, key components in curriculum, instruction, and evaluation, objectives-based programs can be designed and improved.

Curricular Characteristics

The curricula in objectives-based programs are designated by hierarchically sequenced objectives which describe the desired learning outcomes. One of the major advantages of using objectives is that they clearly communicate these outcomes. Decker F. Walker predicted this shift in educational goals when he suggested that: "As professional educators, we are going to have to cope with competency-based education whether we like it or not" (Walker, 1977). Figure 2 illustrates the various influences that affect curriculum development and ultimately the generation of instructional objectives.

Education has responded to the pressure for change by reviewing current programs, and assessing the needs required to meet these emergent values. The goals are transformed into objectives that reflect these goals. The objectives target instruction and describe the desired outcomes to reflect these emergent goals. When objectives are stated as desired outcomes and are supported by an assessment system that is sensitive to changes in students, their instructional needs can be addressed. This type of program is reactive to individual students, increasing the probability of achieving program goals.

Figure 2. Influences on the curriculum

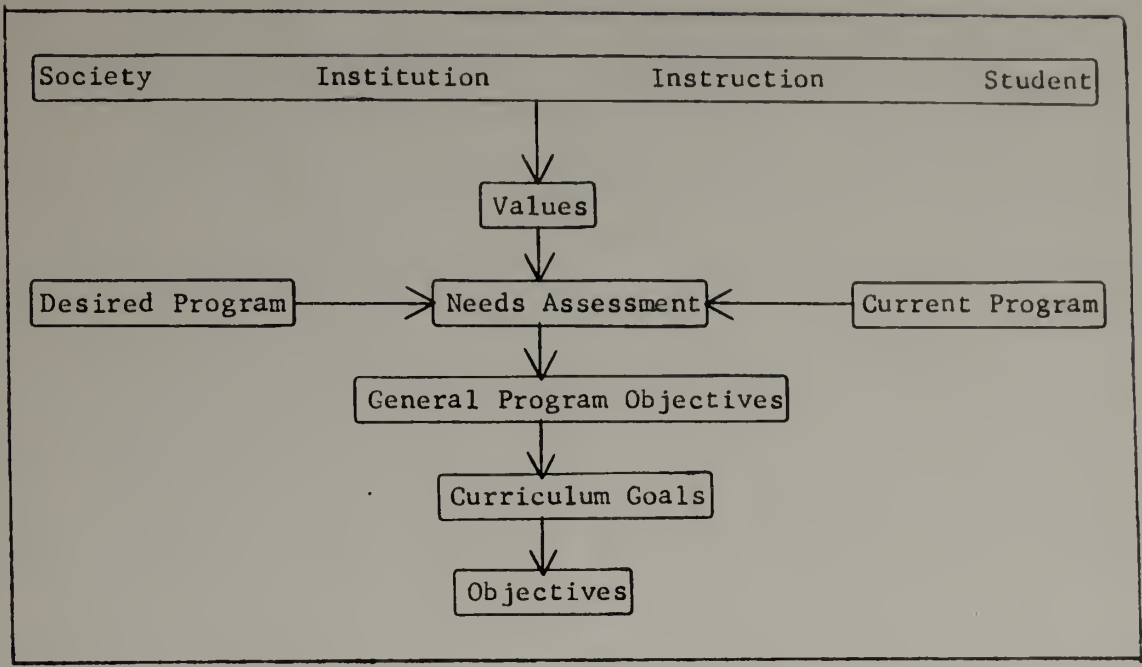
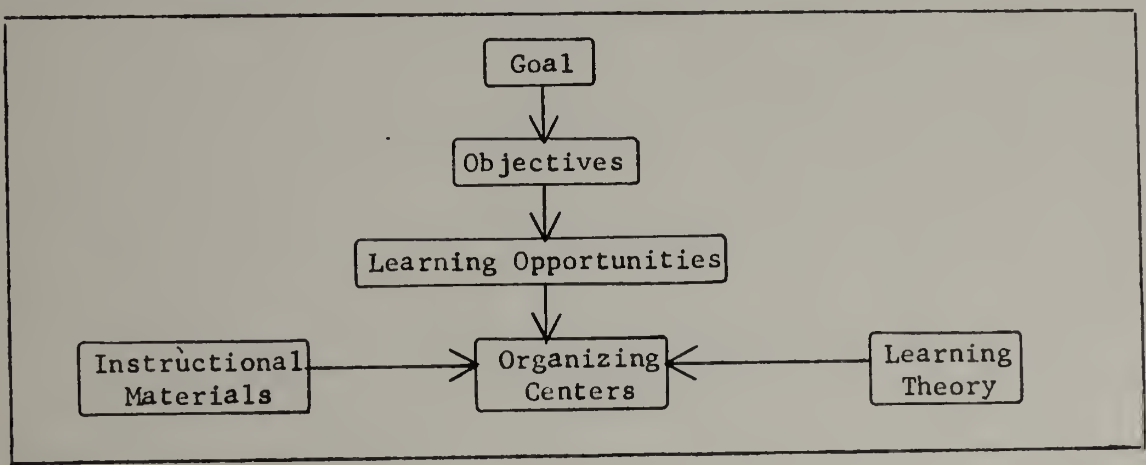


Figure 3. Preparation of instructional stimuli



John McNeil's analysis of objectives summarizes several reasons for their use in basic skills programs. He states:

> They (objectives) specify learning products and processes in forms that can be observed and measured . . . . (objectives) tend to reinforce the importance of conventional goals and traditional divisions of academic subject matter. (McNeil, 1977, p. 37)

In basic skills curriculum objectives clearly define the desired outcomes, provide the foundation for developing assessment tasks, and target instructional opportunities for teachers and students.

Instructional Characteristics

Basic skills objectives are usually limited to discreet, identifiable, observable content or skills. This characteristic makes it possible to organize instruction into small, manageable units. Small samples of student behavior can be observed at the organizing centers where the students actually encounter specific stimuli. It is at the organizing centers that learning takes place as manifested in changes in student behavior. Figure 3 illustrates the instructional potential of a curriculum that is objectively stated.

There may not exist many variations on writing objectives or testing but there are a variety of instructional means for implementing a curriculum. The instructional climate should be characterized by a plethora of options for maximizing learning for all students. A validated testing program provides the data for deciding what to teach to which students and provides information for organizing instruction. The point is that there is no single best way to teach or organize instruction. IGE, IPI, and Mastery Learning encourage instructional flexibility by making adjustments to meet the needs of individual learners. Adjustments are made in the objectives selected, the kinds and number of instructional opportunities, the rate at which students progress, the use of materials, and student interests. Adaptations are also made in the organizing of instructional groupings. The groupings result from the use of information gained through individual or group assessment. Instruction then, is a function of the numerous transactions that mediate between the curriculum and the learning outcomes.

Evaluative Characteristics

Instructional objectives, developed for basic educational programs, generally are quite explicit in describing measurable changes in student behavior. These changes represent the desired curriculum outcomes and serve as the source for developing assessment tasks. Test items are the most common form of assessment tasks. They are used to prepare numerous kinds of tests in objectives-based programs of which criterion-referenced tests are the most popular.

A. Preassessment Tests. One of the most common uses of test items is to assess the entry characteristics of students. Placement testing is a form of preassessment used for placing students on the continuum of program objectives. Students will usually demonstrate different levels of ability and "spread out" at the beginning of a program. Entry testing also provides the base data against which exit testing is judged to determine student progress in the curriculum.

B. Formative Tests. The data from these types of tests are used to make instructional decisions concerning student progress in achieving the desired outcomes. There are three common types of formative tests used in objectives-based programs. The first is the pretest or diagnostic test. This test yields data on the status of students in relation to a following unit of study. Decisions are made about students' strengths and weaknesses in the unit and appropriate instruction is planned. The unit posttest and retention tests are other types of formative tests. The retention test commonly tests for the retention of mastery on objectives previously mastered.

C. Summative Tests. End of year tests are summative tests. The common purposes for this form of assessment are: to measure how students progressed during the year on the program objectives when compared to the preassessment data, to analyze the effectiveness of the program and to judge program worth.

2.4 Summary

This chapter presented a review of the research on the major elements of objectives-based programs that contribute to significant gains in student performance. Then, the more common characteristics of objectives-based programs were described in the categories of curriculum, instruction, and evaluation. The research and the characteristics provide the background for designing a model to promote the systematic development and implementation of objectives-based programs. It is only through systematic development that education can determine where the gaps are and design research. The following chapter will present a systematic model for designing objectives-based program. The contributions of the curriculum, instruction and evaluation will be addressed.

CHAPTER III

A MODEL FOR THE DESIGN AND IMPLEMENTATION OF OBJECTIVES-BASED PROGRAMS

3.1 Introduction and Purposes

The two previous chapters addressed the background of the competency-based education movement, the research that supports student gains resulting from objectives-based programs, and the common characteristics of objectives-based programs. In this chapter a model for the systematic design and implementation of objectives-based programs will be presented. The model will serve five purposes:

1. it will incorporate research proven attributes,
2. demonstrate the interrelationship among the curriculum, instructional and evaluative components,
3. incorporate recent technology in criterion-referenced test development,
4. present other educators a framework for similar development and implementation, and
5. provide the basis for the implementation undertaken in this study.

The curriculum and evaluative components of the model will be examined in detail in Chapters IV and V.

The basis for the model is developed from four critical questions posed by Ralph W. Tyler (1949) and Harriet Talmage's (1975) response by transforming them into a model for instructional design. In her reply she changes each question into a construct and then adds fifteen components to further clarify their intent. Talmage reverses the order of Tyler's second and third questions. She states (Talmage, 1975): "I feel that organization of the content for developing individualized instructional delivery systems needs to precede methodological considerations." The transformation of Tyler's questions into Talmage's instructional design model is illustrated in Figure 4.

Each of the components in Talmage's instructional design will be included in the model developed to accomplish the purposes of this study. The following section presents a model for the design and implementation of an objectives-based program. The presentation of the model is followed by a description of the contributions of the curriculum, instructional and evaluative components. Each section will begin with a more detailed description of the model.

3.2 The General Model

The assessment of needs was precipitated by the results on the New York State third and sixth grade mathematics tests. The scores have not changed appreciably in the last five years as shown in Table 1. All public and private schools must administer these tests to all third and sixth grade students each year as part of the Statewide Pupil Evaluation Program.

The percentage of children scoring below the state established minimum competency level of the third stanine must participate in a remedial program. Reference to Table 1 indicates that there is a considerable difference between the percentage of students requiring remediation in third and sixth grade. This difference has been a concern to the professional staff and the board of education. The superintendent of schools directed the curriculum supervisor to establish a committee to

Figure 4. Talmage's (1975) transformation of Tyler's (1949) questions into instructional design

Ralph W. Tyler's Questions	Harriet Talmage's Instructional Design
1. What educational processes should the school seek to attain?	1. Objectives a. Entry Behavior b. General Program Objectives c. Specific Learning Objectives
2. How can learning experiences be organized for effective instruction?	2. Organization a. Structure of the content b. Sequence c. Scope d. Branching e. Recycling
3. How can learning experiences be selected which are likely to be useful in attaining these objectives?	3. Modes of Transaction a. Teacher-Learner Roles b. Management of Learning Environments c. Grouping d. Modes of Presentation e. Time and Pacing f. Learning Activities
4. How can the effectiveness of learning experiences be evaluated?	4. Evaluation a. Normative-Criterion Referenced b. Teacher-Learner Referenced

TABLE 1

NEW YORK STATE TEST RESULTS

FIVE YEAR MATHEMATICS RESULTS

	Percentage of Students Below Minimum Competence				
	Year				
Grade	1975	1976	1977	1978	1979
Third	8	7	5	5	6
Sixth	20	22	23	21	23

study the problem and make recommendations. In order to provide guidance and direction to the project the curriculum supervisor developed the model for the design and implementation of objectives-based programs shown in Figure 5. The committee formed included: the curriculum supervisor, an elementary principal, three elementary teachers, the junior high school mathematics coordinator, and a board member who was also a parent. They undertook the tasks of assessing the needs highlighted by the discrepancy in the scores between the third and sixth grade students and resolved to collect data to assess the problem.

The committee reviewed the state test results for the last five years, analyzed the content of the tests, developed and administered a test built upon the state test, reviewed student cummulative records and interviewed intermediate grade teachers.

The results of these data gathering process indicated that:

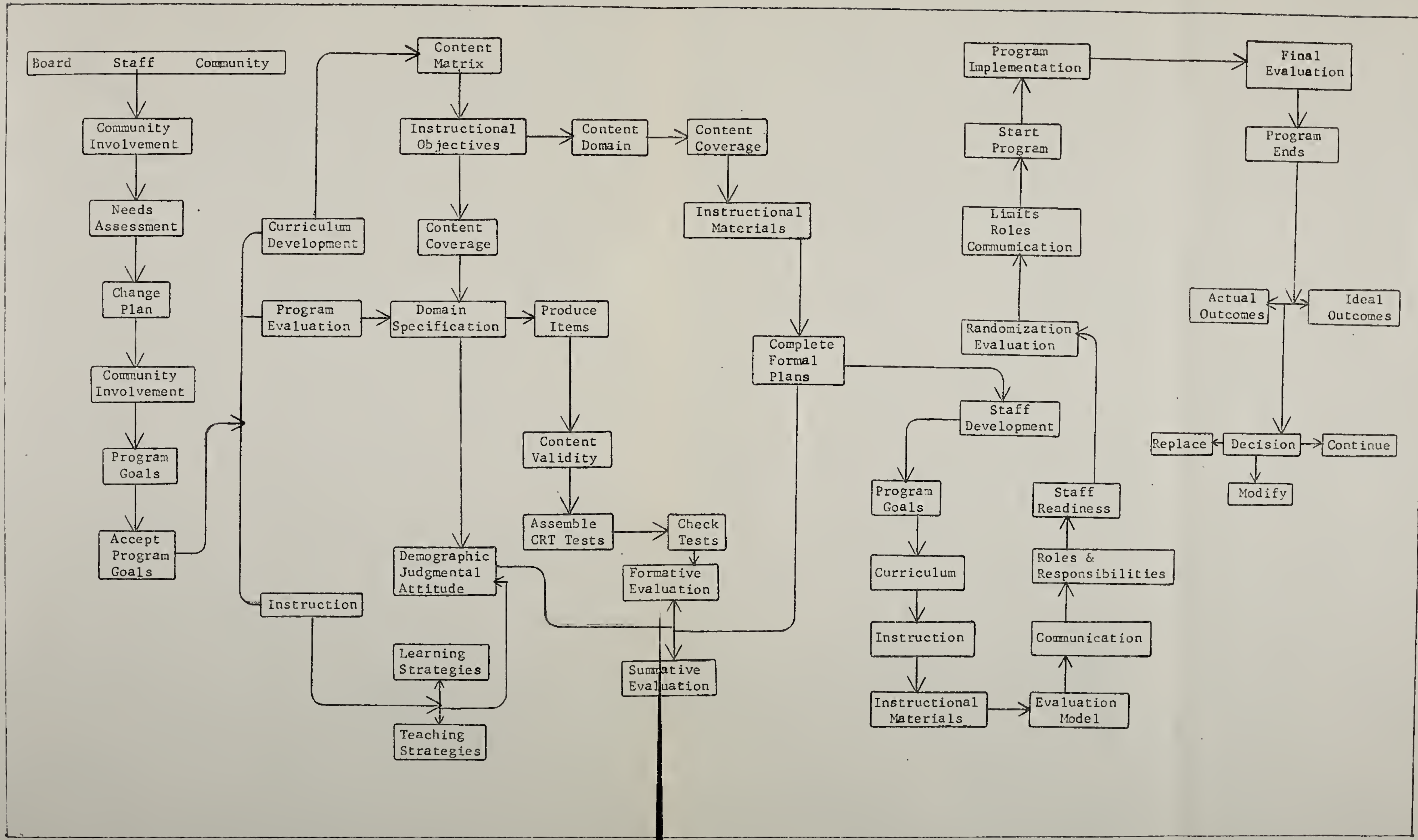
1. There has been a consistent difference in the percentage of students below minimum competence in third and sixth grade.

2. Of the 67 items on the sixth grade test: seven dealt with numeration; sixteen dealt with measurement, time, and money; four dealt with addition; five dealt with subtraction; four dealt with division; eight dealt with multiplication; thirteen dealt with fractions; three dealt with geometry; seven dealt with applications.

3. Upon closer examination the items were categorized as testing skills in numeration, elementary operations, measurement, rational numbers, geometry, problem solving.

4. On a test developed to assess sixth grade student skills developed from items similar to that on the state test (two items for every one on the state test) the results indicated that students demonstrated weaknesses in rational numbers, numeration, elementary operations, and geometry.

Figure 5. A model for the design and implementation of objectives-based programs



5. Interviews with sixth grade teachers corroborated the findings of the test and their assessment of weaknesses in their daily instruction.

Upon reviewing this evidence the study committee met to establish general and specific program goals. The committee cognizant of the assessed needs and aware of the current movement for competency-based education nationally and in the state developed the following program goal.

> The elementary mathematics program must guarantee that by the end of sixth grade elementary students will demonstrate sufficient competence in mathematics to successfully function as adults in today's world.

Once established the committee met to translate this general progam goal into specific program goals which were:

1. Select and present all elementary students instructional opportunities in "basic" mathematical skills and content deemed necessary to function as adults.

2. Develop a means for assessing individual student mastery of basic content and skills throughout the school year and at the end of the year.

3. Design a system for monitoring individual student progress in a basic mathematics program during the year and at the end of the year.

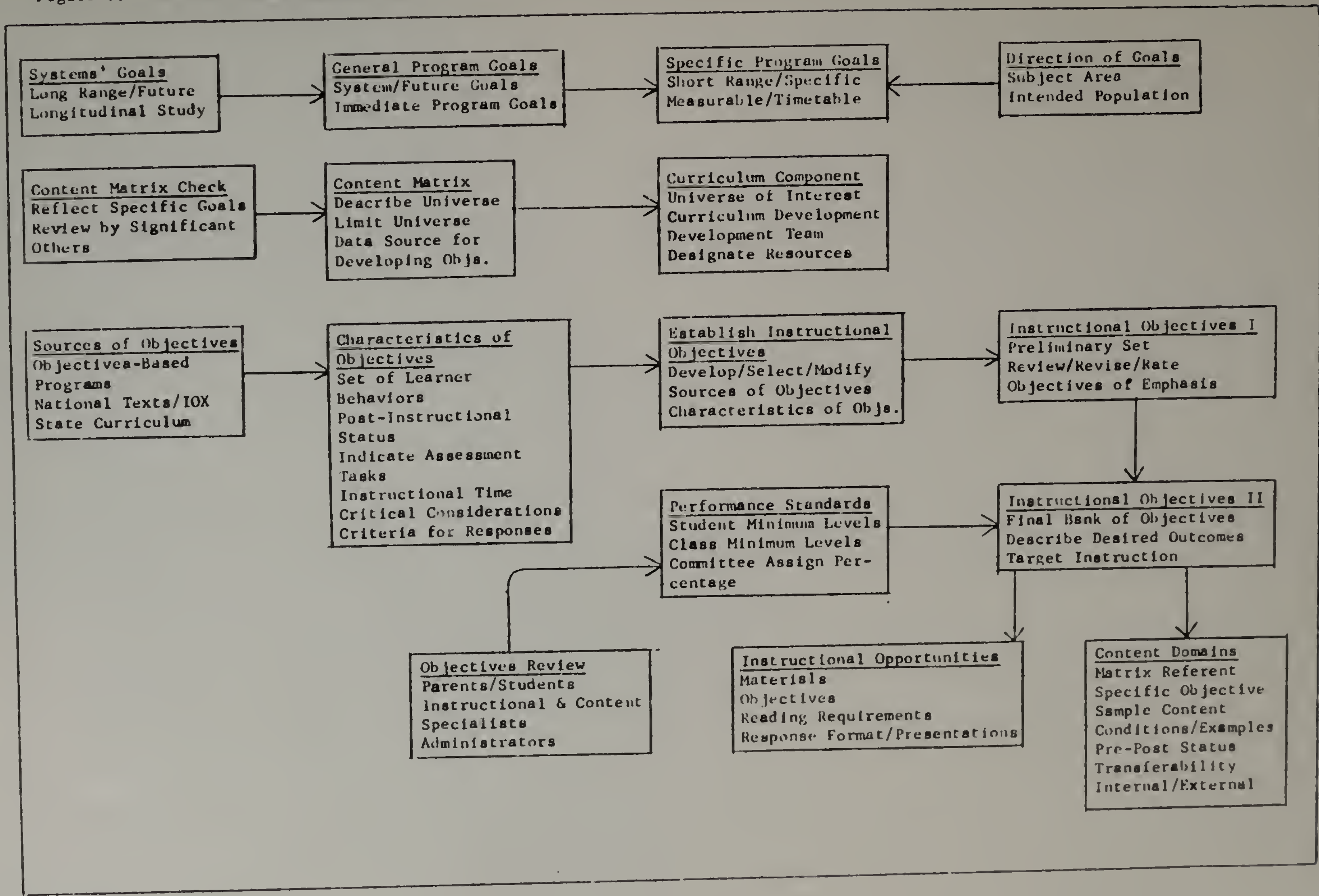
The program goal and the specific program goals were presented to the superintendent of schools. He accepted the committee's recommendations, promised support for their implementation and appointed the curriculum supervisor to direct the study to achieve them. It was at this point that the preliminary planning stage was completed. The curriculum supervisor guided the project as it moved into the formal development and planning stage commencing with curriculum development as reported in the next section.

3.3 The Curriculum Component

The project director expanded the curriculum component of the model for the design and implementation of an objectives-based program. The expanded curriculum model illustrated in Figure 6 served as the guideline for the continuation of the project. Curriculum development started with the assignment of three mathematics specialists to the project: an elementary teacher, a Title I mathematics teacher, and the junior high school mathematics coordinator. The goal communicated to this development team was to develop and organize a "basic set" of instructional objectives in rational numbers, numeration, and elementary operations. In order to accomplish this task the team reviewed: the New York State Mathematics Curriculum Guides, and three commercial mathematics programs used in the elementary schools (The Holt Mathematics Program, The Houghton-Mifflin Mathematics Program, and the Individualized Mathematics System). The purpose of this review was to organize a content matrix upon which instructional objectives in the three strands (numeration, rational numbers, elementary operations) could be organized and sequenced in a form most familiar to teachers. This review resulted in a listing of content in each strand thus defining the universe of the basic mathematics program for third through sixth grade students and teachers.

The next step in the process was to translate the defined content into instructional objectives. The development team reviewed a number of sources of objectives: the three commercial programs listed above, the objectives from the Instructional Objectives Exchange (IOX), and

Figure 6. The curriculum component model



Project Plan. These presented problems in formating so it was decided to utilize a set of characteristics in order to select, modify, and develop a set of instructional objectives. Popham's (1975) descriptions of what are well defined objectives served as the basis for answering this need:

1. Each objective must describe the desired post-instructional status of the learner in unequivocal terms.

2. The objectives should indicate how the post instructional status of the learner will be assessed.

3. The objective must describe a set of learner behaviors that usually require three or more days of instruction.

4. The objective must suggest the development of numerous assessment tasks.

5. The objective must incorporate all important conditions associated with it.

The development team produced a set of 79 objectives in the numeration, rational numbers, and elementary operations strands. Each objective represented a consensus of the best possible characteristics among the three members of the team and the curriculum supervisor. Once the objectives were completed the development team separated them into grade levels by use of common or most frequent placement in the three commercial programs used in the district as illustrated in Table 2. (Refer to Appendix A for the listing of objectives. Please note that the number of objectives increased due to activities described later in the study.) This is the point at which the curriculum development component ends.

Defining a preliminary set of objectives sets the stage for the next step in the model, the development of domain specifications which

TABLE 2

NUMBER OF OBJECTIVES DEVELOPED IN THE GRADES 3-6
MATHEMATICS CURRICULUM

Grade Level	Mathematics Strand		
	Elementary Operations	Numerations	Rational Numbers
3	9	3	5
4	11	6	5
5	13	8	1
6	10	4	4
TOTAL	43	21	15

will be described in the evaluative component of the model.

3.4 Instructional Component

The instructional component is the second major section of the formal planning and development stage of the implementation. Although this implementation was not part of this study a brief description is included in order to more fully describe the model. Johnson (1977) has designated the instructional process as the instrumental content because it intervenes between the curriculum and the learning outcomes and is the variable that most directly affects student achievement as illustrated in Figure 7. The instrumental content is best described as that which is selected by teachers to facilitate achievement of the desired outcomes. The factors that support facilitating behavior by teachers are outlined in the instructional component model illustrated in Figure 8.

In addition to the model, following are several implications for instruction taken from the research on objectives-based programs:

1. The curriculum is organized in a hierarchical sequence of objectives stated in terms of intended learning outcomes. The implication for instruction is that the teachers must be aware of the objectives and their sequence in order to plan instructional opportunities for students. Objectives in a basic elementary mathematics program provide discrete, logical steps of skills and content that students must master as they progress. The possibility of increasing student performance is enhanced by informing students of the objectives they are working toward.

2. Instruction commences with an assessment of pupil entry competencies. The preassessment or placement test provides instructional specialists a profile of individual students' status in relation to the objectives expressed in the curriculum. Student performance is individually referenced to this learning continuum. Standards are established in order that students can be classified as masters or non-masters on

Figure 7. A pupil change model

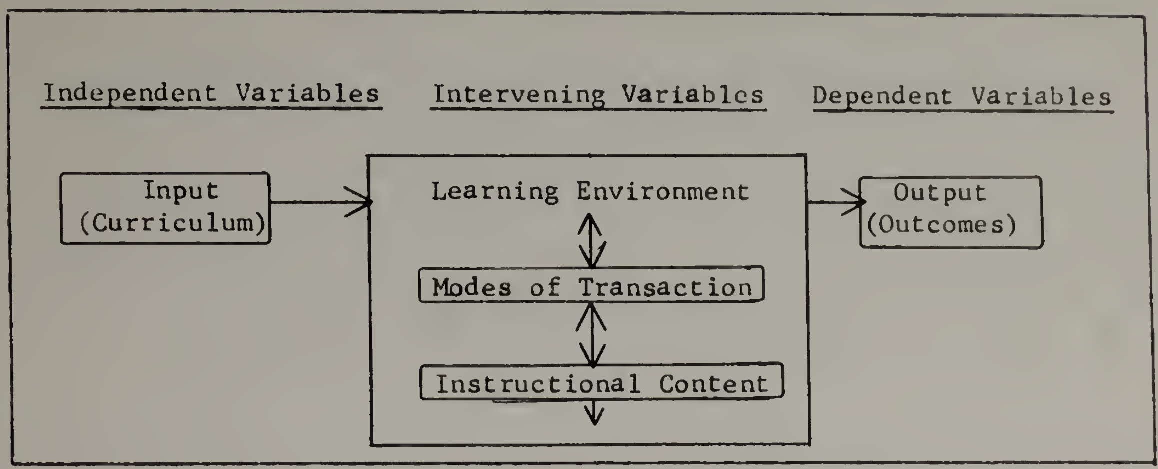
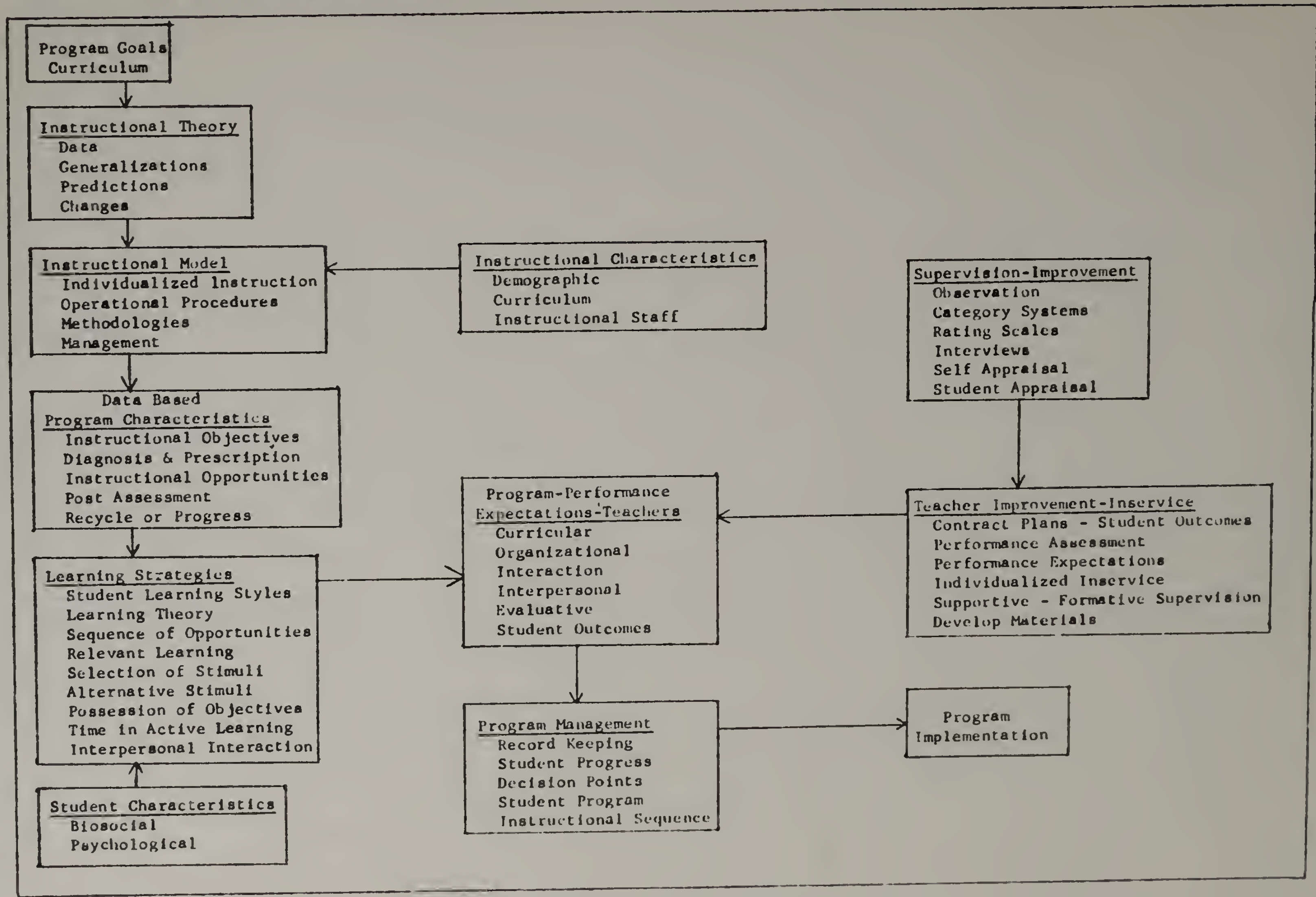


Figure 8. The instructional component model



each objective. The placement test consists of a set of subtests directly related to the program objectives.

3. Instruction is sensitive to individual student needs and abilities and provide flexible instructional opportunities. Adjustments to student needs are made in the rate at which students are expected to progress, the time spent in active learning, the use of alternative stimuli in the learning opportunities, the options to recycle students through alternative stimuli, and the attention given to various learning styles. The learning environment is organized to reflect and support these options and the various mastery levels of the students. Students are flexibly grouped according to diagnosed needs or abilities.

4. Individual student performance is continuously measured and progress monitored. Diagnostic pre- and post-unit, and curriculum embedded tests are used to assess student performance and monitor progress. Mastery standards are necessary to determine if a student has demonstrated competence in each objective.

5. Formative data are used to make program adjustments. Instructional specialists and supervisors assess the program's effectiveness in promoting pupil learning in progress. This requires periodic or continuous evaluation of tests, instructional materials, teaching, the objectives, and the other factors that directly affect instruction as listed in Figure 8.

6. Instruction terminates with a post assessment of student status in relation to program objectives. Measures of student mastery on each of the basic mathematical objectives is critical to determine student achievement. These in combination with other evaluative means are used to determine program worth. Ideally the status of students at the end of instruction will reflect the goals expressed in the curriculum.

3.5 Evaluative Component

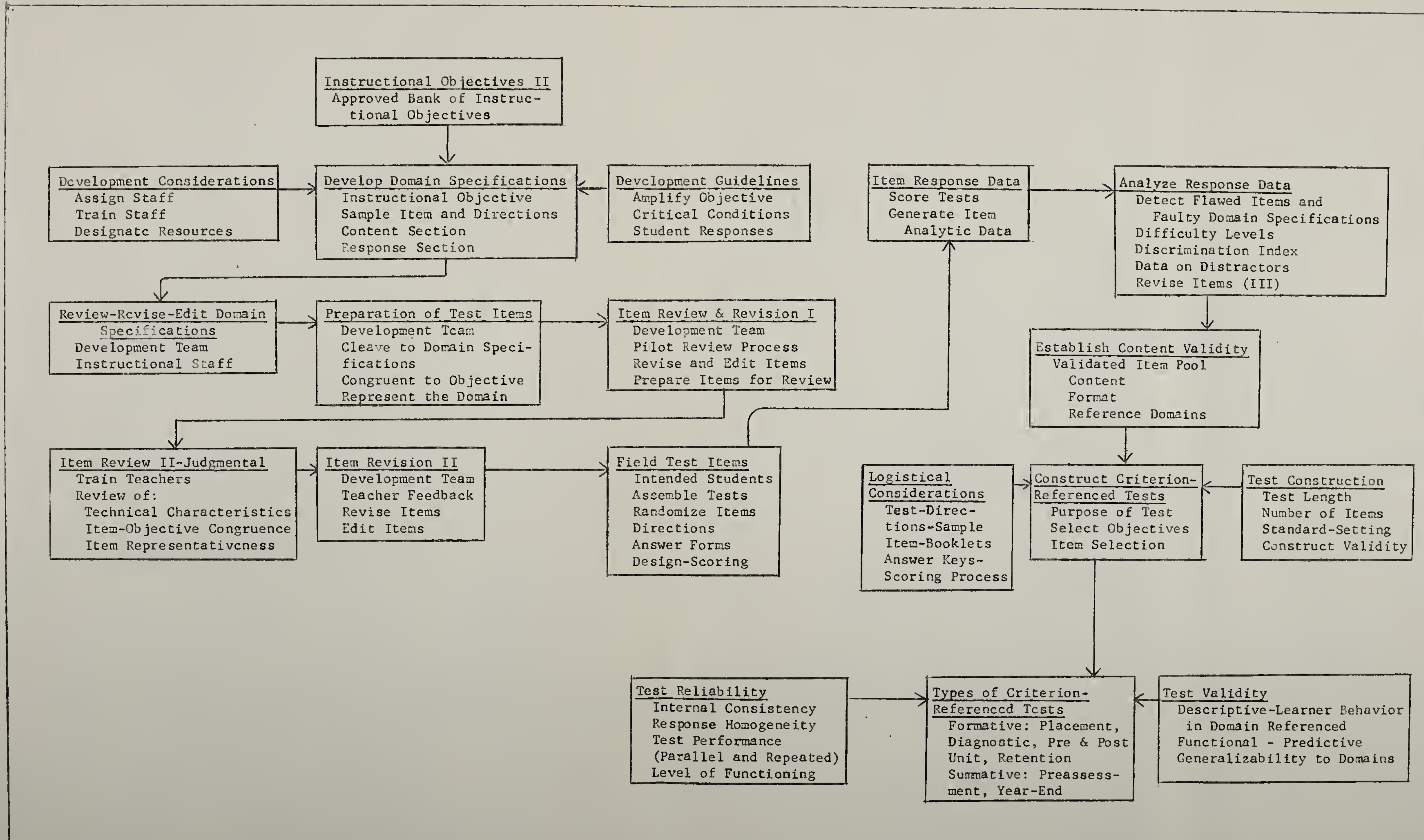
In the formal planning and development stage in the implementation of an objectives-based program the curriculum and evaluative components intersect at the instructional objectives as illustrated in Figure 5. The instructional objectives provide the basis for criterion-referenced test development in the model presented in this study. Whereas in the test development model selected for this study (Hambleton, 1980) the objectives are prepared and reviewed in step 2. There is nothing incompatible about the junction of the two models. In Hambleton's (1980) "Steps in Building a Criterion-Referenced Test" it is not assumed that program objectives have been previously developed. This is also true of the conditions listed in the step. The purposes of the test, the content area, the grade levels, and the allocation of resources were accomplished prior to curriculum development. The point at which both models coincide is in the second step of Hambleton's model where the process of clearly-defining objectives amplifying them into domain specifications commences as show in Figure 5.

Steps in Building a Criterion-Referenced Test

The development team was assigned the task of more clearly defining the objectives by amplifying them into domain specifications. They were trained in the process by the curriculum supervisor using the materials developed by Hambleton and Eignor (1979). They developed a domain specification for each objective. A domain specification review form was piloted by the team members in reviewing each others work. The domain specifications and the review form were revised and readied for the teacher review of the domain specifications. These processes, outlined in Figure 9, are more completely described in Chapter V.

In step 4 the content specialists prepared ten items for each domain specification. They followed the guidelines incorporated in the domain specifications and cross reviewed, discussed, and edited the items. An item review form was piloted and revised during the review.

Figure 9. Evaluative component model (Hambleton, 1980)



In step 5 a minimum of three instructional specialists per grade level systematically reviewed the test items. Using the item review form they recorded their judgments regarding the congruence between the items and the objectives, the technical quality of the item stem and alternative responses (distractors), the quality of the distractors, and how well the items represented the possible limits of content circumscribed by the domain they were prepared to measure. The feedback from the judgmental review was used by the content specialists to revise the items and the domain specifications. The revisions required additional item reviews before field testing the test items with students. The test items were randomly assigned to different test forms which, in turn, were randomly administered to students in each grade level. The test forms were computer scored and item analysis data generated.

In step 6 the item analysis data were used to detect flawed test items and faulty domain specifications. The data used in the detection of flawed items (and domain specifications) were the difficulty level, the discrimination index, the spread of responses among distractors, the distribution of high and low scorers in the correct answer and distractors, and the range of difficulty levels among the ten test items for each domain specification. Steps 4, 5, and 6 will be examined in detail in Chapter V. The remaining steps in model are briefly described to complete the continuity of Hambleton (1980) test development model.

Steps one to six resulted in the development of a validated item pool for each objective of interest. Items can be selected from this pool for a number of purposes in a basic mathematics program. They are pre- and post- assessment of units of instruction or the year's program, placement testing, tests to determine retention of skills, and as part of a summative evaluation to determine program worth. The purposes of the tests must be determined before test assembly begins.

First among the test assembly decisions is the determination of test length. Test length is the product of the number of objectives of interest and the number of items per objective required to render consistent scores for making instructional decisions.

Once the length of the test has been determined the test developer must select the test items. The mathematics domains in this study are rather narrow and the items homogeneous. The care with which the objectives were developed, the domains defined, and the means by which items were written, reviewed, and revised obviates rigorous domain sampling techniques. A random selection of items from the domains of interest will suffice for almost any testing purpose. If the purpose of testing is to make very important mastery and non-mastery decisions the test maker might consider the statistical properties of the items.

Once the test length has been determined and the items selected, the remaining steps in the test assembly process are logistical in nature. Refer to questions 15 through 20 in Hambleton (1980) "Suggestions for Selecting and Evaluating Criterion-Referenced Test" for helpful suggestions in the preparation of directions, sample questions, design of the test booklet layout, and the preparation of scoring keys and answer sheets.

Standard setting in criterion-referenced testing is a complex issue that evokes numerous points of view. It arises in step 8 in Hambleton's model. There is agreement among researchers that standards are necessary to make decisions about student progress or needs. The usual categorization of students as masters or non-masters requires a point of differentiation. Hambleton (1980) presents a discussion of the issues and cites several methods for standard setting.

The results of each testing contribute data toward the on-going improvement of tests, items, validity and reliability information and ultimately instructional and program decisions and evaluation. These areas are covered in steps 9 to 12 of the Hambleton model.

Criterion-Referenced Testing and Instructional Management

In day-to-day instructional management, criterion-referenced measures provide detailed diagnostic information about each student, information that is useful in making instructional decisions concerning student needs, mastery and retention of skills on each objective in the curriculum.

An examination of the characteristics of criterion-referenced tests will indicate their potential for integrating curriculum, instruction, and testing into a cohesive objectives-based program. The following characteristics render criterion-referenced tests an excellent means for assessing pupil progress in objectives-based programs (Popham, 1975; Hambleton, 1973, 1980; McNeil, 1976; Kibler, and others, 1974; Millman, 1974):

1. They are designed to reference an individual student's status in relation to well-defined classes of behavior.

2. They assist in diagnosing what a student can and cannot do on the desired outcomes specified in each objective.

3. They are sensitive to instruction and thus can be used formatively, that is, simultaneous with instruction; as a student learns his/her progress can be monitored.

4. They can provide evidence of the standing of a student in relation to objectives of a course or program and ultimately its curriculum goals.

5. They lend themselves, because of their flexibility, to evaluating programs and instruction.

3.6 Summary

A proposed model for the design and implementation of objectives-based programs has been presented and three of its essential components outlined and described. In Chapter IV the objectives produced in the curriculum component will be more clearly defined by the process of amplification into domain specifications. In Chapter V the steps for building a criterion-referenced test described in the evaluative component section of this chapter will be implemented through step 6.

CHAPTER IV

DOMAIN SPECIFICATION WRITING AND REVIEW

4.1 Introduction and Purpose

In Chapter III the purpose for developing a basic mathematical skills curriculum and testing program were established. The mathematical strands were identified, objectives were developed, and the intended pupil population designated. The focal point of this chapter is the use of objectives as the starting point for the implementation of the evaluative component of the model which culminates with the development of criterion-referenced tests. Hambleton (1980) states the essential linkage between objectives and criterion-referenced tests:

> criterion-referenced tests . . . . are constructed to permit the interpretation of individual (and group) test scores in relation to a set of clearly defined objectives or competencies.

Popham (1975) reinforces this view when stating his reasons for constructing criterion-referenced tests:

> a criterion-referenced test is constructed to assess the performance levels of examinees in relation to a set of well-defined objectives.

They both refer explicitly to clearly defined objectives which are more specialized than those developed in Chapter III. The previously developed objectives must be amplified in order to serve as guidelines for the production of items. Criterion-referenced tests will be constructed with these items whose results can be interpreted with confidence. This amplified form of an objective which clearly defines a domain of behavior is called a domain specification. It is the domain of behavior defined in the specification that is the "criterion" in criterion-referenced tests or measurement. Hambleton (1980) defines criterion as "a domain of content or behavior to which test scores can be referenced".

The purpose of this chapter is to report on how objectives were amplified into domain specifications, how they were reviewed and revised, and then serve as the foundation for the next step in the investigation, the development of test items (Chapter V). The description of the process of expanding objectives will be highlighted with examples of directions for teachers, samples of forms and memos used, and synopses of meetings.

4.2 Amplification of Objectives into Domain Specifications

Domain Specification Sections

The process of amplifying objectives into domain specifications is a common practice for clearly defining the domains of content or behavior (Hambleton, 1980; Popham, 1978). The structure of a domain specification used in this investigation is illustrated in Figure 10. A complete description of each part of a domain specification is offered next.

Section 1. Skill (Objective). This section contains the instructional objective developed in the curriculum component. The objective describes a discrete set of content or behaviors. It should suggest to any person, knowledgeable in the content area, a discrete set of content with definable limits. The objective should also suggest a class of clearly defined behaviors that lend themselves to the development

Figure 10. Major sections of a domain specification

Domain Specification No. _______

Section 1. Skill (Objectives)

Section 2. Sample Item and Directions

Section 3. Content Section

Section 4. Response Section

of assessment tasks (test items).

Section 2. Sample Item and Directions. The primary purpose of this section is to illustrate an example of the content, defined by the objective, in a sample test item. The item must reflect the most common content and conditions implied by the objective, describe the expected behavior, and serve as a model for developing other items to measure the objective.

Section 3. Content Section. This section expands upon the characteristic content suggested by the objective and further amplifies its intent by establishing content limits. The format for presenting the content is also described. Popham (1978) refers to this section as the stimulus attributes, "a series of statements that attempt to delimit the class of stimulus material that will be encountered by the examinee". In summary, the content section presents the range of content circumscribed by the objective, and targets the stimuli for instructional and evaluative purposes.

Section 4. Response Section. The response section describes the characteristics of the alternative answers. (In all the mathematics items the multiple choice format was used.) This section includes the number of possible responses, the suggested order of the responses (ascending or descending, or mixed), and a description of the distractors and other common mistakes made by students.

Development of Domain Specifications

The objectives were divided among three content specialists. Each developer used the guidelines previously illustrated and developed a domain specification for each objective. Once completed, the domain specifications were redistributed to the specialists for review and revision. They piloted the use of a domain specification review form developed for this process. (The form will be described in the following section.) This process accomplished two goals; first, the use and revision of the form, and second, the first review and revision of the domain specifications prior to distribution to teachers for their review. A completed domain specification is illustrated in Figure 11.

4.3 Teacher Review of Domain Specifications

It was decided to use the third through sixth grade faculty at one of the elementary schools for the review of domain specifications. The decision was based on the following factors:

1. They were a representative sample of the other third through sixth grade teachers in age, experience and abilities.

2. Their classes are heterogeneously grouped and the range of student abilities varied from remedial to high ability and was representative of the spread of students in the same grades in the other two schools.

3. The faculties of the different schools undertake different projects each year and they would participate in this study.

4. The school principal understood the project and was supportive of its goals.

Domain Specification Review Form

A meeting was held with all third through sixth grade teachers and the principal of the school to explain the project and initiate the review of domain specifications. The purposes of the meeting were to reiterate the district goal of implementing a basic mathematics program, and to review the domain specification form and its

Figure 11. A sample domain specification

Domain Specification 3.17

Skill (Objective):

Given a three-digit whole number, the student will be able to identify the digit corresponding to a specific place value.

Sample Item and Directions:

Read the problem carefully and choose the correct answer. Place the letter beside your answer on the answer sheet next to the number of the problem.

In the number 483, which digit is in the hundreds place?

a) 3 c) 8

b) 4 d) 483

Content Section

1. The student is given a three-digit whole number, and asked to identify a specific place value.

2. The requested place value will be written in words within the question and numbers in the choices.

3. The following phrase precedes each item: "In the number ____ which digit is in the ____ place." The first blank refers to the given three digit whole number, while the second blank refers to the specific place value requested.

Response Section:

1. The student will be given a choice of four alternatives.

2. The items will contain one correct and three incorrect responses.

3. The distractors will be:

   a) the incorrect digits of the whole number.

   b) the whole number itself.

4. The responses will be listed in either ascending or decending order.

use.

A. Context Setting. A district goal, of a number of years, has been the differentiation of mathematics education. The teachers and administrators had worked for several years on the implementation of a program for individualizing and grouping of students in mathematics using program-embedded placement and diagnostic tests. The program lacked a core of required or basic skills; skills that have a fair expectation of mastery by the minimally competent elementary student upon completion of sixth grade. It is with this background that the initial meeting was held.

B. The First Faculty Meeting. The first meeting was held with the third through sixth grade teachers to discuss the background and purpose of the project and to introduce and explain the use of the domain specification review form. Following is a synopsis of the meeting.

The discussion at the meeting focused on the progress of the elementary mathematics program, the need to monitor the progress of minimally competent students, and how selected basic skills objectives and items could contribute to solving this need. The process by which the objectives were produced and their definition expanded through the development of domain specifications was explained. Special emphasis was placed on how domain specifications can minimize ambiguity by targeting what is to be taught and tested. The teachers were informed that by their input into the process they will develop confidence in the tests and the test data which will be used to make instructional decisions about individual students. The format of the domain specifications and the domain specification review form (refer to Figure 12) were then presented and discussed. The essential elements discussed are presented next.

C. Essential Elements and Rationale. Following is a synopsis of the domain specification review form presentation.

1. Introduction

The domain specifications amplify instructional objectives. They present in their format what is going to be taught and how it is going to be tested. This is cummulatively presented in four sections: the skill (objective), the sample test item and directions, the content and the response sections. An examination of a domain specification by using a domain specification review form will assist in developing an understanding of both the intent of the four sections and the purpose of the review form.

2. Skill (Objective) Section

The first question addresses the issue of whether the objective suggests identifiable content and identify the nature of the items that will be used.

3. Sample Item and Directions

The purposes of this section are: to examine the sample directions and the test item for clarity, appropriate vocabulary, and format, and to insure that the sample item will serve as a good model for developing other items to measure the objective.

4. Content Section

The purpose of reviewing this section is to check for additions, deletions, or revisions in the content to improve clarity by defining acceptable limits of content.

5. Response Section

The purpose of reviewing the response section is to check the rules for possible revisions in the distractors, the numbers of alternative answers, and the order of the possible answers.

Figure 12. Domain specification review form

Domain Specification No. _____ Teacher _______________________

Domain Specification Review Form

Skill (Objective) Section

1. How might the skill section be revised to improve its clarity?

Response ____

____

____

Sample Item & Directions

2. Can the test directions be revised to improve their clarity?

____Yes. Please write the revision on the domain specification sheet.

____No. They are clearly written.

3. Do you feel that multiple choice format is appropriate for measuring this skill?

____Yes, it is appropriate.

____Yes, with reservations. (Please try to explain) ____________

____

____No! If no, what item type would be best? (Please try to explain) ____

____

4. Will the sample test item serve as a good model for item writers in preparing other items to measure the skill?

____Yes, it is appropriate.

____Yes, with reservations. (Please try to explain) ____________

____

Figure 12. Continued

____No! If no, what item type would be best? Write a sample test
Write a sample test item directly on the domain specification.

a. What do you think about the number of choices?

____too few ____too many ____just right

b. What do you think about the vocabulary used in the item?

____too hard (indicate change on the domain specification)

____too easy (indicate change on the domain specification)

____just right

Content Section

5. Do you have any suggestions for revising or extending the content defined by the skill?

Please write your comments directly on the domain specification. Your comments could include;

- deletions of specific content,
- additions to the content, and
- reqrite of content for clarification.

Response Section

6. Do you have any suggestions for revising or extending the characteristics of the possible answer? (Please write your comments directly on your copy of the domain specification.)

Please staple the domain specification to this form when you have completed your review.

Teachers were then asked to review one sample domain specification in order to familiarize themselves with using the form and to clear up any misinterpretations. The teachers were then given a set of forms and domain specifications for review and a deadline set for their return. The distribution of domain specifications for review is illustrated in Table 3.

In all grades a minimum of three teachers reviewed each domain specification. In third grade, each of the four teachers reviewed thirteen of the seventeen. In fourth grade, each of the four teachers reviewed either sixteen or seventeen of the total of twenty-one. In fifth grade, each of the five teachers reviewed fifteen of the total of twenty-five. In sixth grade, each of the four teachers reviewed eleven or twelve of the total of fifteen.

Teacher Review

The domain specifications were returned individually as each was reviewed, and a log was kept. A reminder was sent to every teacher who was late with returns. Whenever all three reviews for a domain specification were received, all the comments were recorded on a summary form designed for that purpose (refer to Appendix B). The summary form consisted of: the names of the three reviewing teachers, the domain specification number, and a category for each question on the domain specification review form. All the comments and suggestions were consolidated in the categories: skill section, test directions, multiple choice format, sample item, number of choices, vocabulary, content comments and response comments. The content specialists decided if the suggested revisions were minor and/or necessary to

TABLE 3

DISTRIBUTION OF DOMAIN SPECIFICATIONS TO TEACHERS

Teacher	Grade	Domain Specifications
1	3	1-13
2	3	1-9, 14-17
3	3	1-5, 10-17
4	3	1, 6-17
1	4	1-17
2	4	1-12, 18-22
3	4	1-6, 13-22
4	4	7-22
1	5	1-15
2	5	1-5, 16-25
3	5	6-20
4	5	1-10, 21-25
5	5	11-25
1	6	1-12
2	6	1-9, 13-15
3	6	1-5, 10-15
4	6	6-15

incorporate in a revised domain specification. If the reviewing teachers' remarks were such that they required discussion, two or more content specialists met to examine the comments and revise the domain specification accordingly.

Revision of Domain Specifications

The teacher-suggested revisions requiring discussion and re-examination by content specialists usually fell into one of the following categories:

A. Content

1. Broadness of the Objective. The limits of the content defined by the objectives or established in the content section were too broad for the grade. The reviewers remarked that the mathematical limits should be narrowed because the difficulty level of the problems were inappropriate to assess pupil knowledge or skills.

2. Content Difficulty. The content or skill of the domain was too difficult for the grade level.

3. Common Practice. The content was not always presented in an item form that students had experience with.

B. Test Directions or Vocabulary

1. Appropriate Mathematical Usage. Several teacher comments were aimed at either the misuse of a mathematical term or definition, or the teachers expressed a hesitancy to use the term at the grade level. In the latter case, the usual teacher response stated that they taught the concept for understanding and introduced the mathematical term when appropriate.

2. Directions. Teachers commented that several sets of directions were too long, too complex, used terms unfamiliar to students, or that the vocabulary required too high a reading level for most students in the grade.

C. Sequence

The teachers' comments caused occasional problems in the sequencing of the objectives in a strand. They legitimately suggested that the content was too difficult for the grade, but moving the objective to the next grade would leave a gap in the sequence of the original grade. When this occurred, simpler domain specifications were developed to fill the gap. Then both were reviewed, and possibly revised before the set of domain specifications could be completed for a given grade.

D. Test Items

Many teachers wrote their comments directly in the sample test item section. The content specialists would recategorize them before making the revisions. Three important comments were made in this section: 1. Suggestions were made regarding the most common format for many test items, 2. Teacher comments were very helpful in suggesting more common distractors, and 3. Quite often upon reviewing the items the teachers commented that the range was too broad (many suggested that the objectives be split into two domain specifications).

Return of Revised Domain Specifications

Once the domain specifications had been revised some were returned to reviewing teachers for comment as illustrated in Figure 13. The kind of revision determined whether or not it would be returned. When a domain specification was split, or totally redeveloped, or its grade level changed it was reviewed anew. Then the process would be continued until agreement was reached. Content specialists played a special role in the revision process. They have the expertise to judge whether teacher reviews were appropriate, whether the sequencing within strands would be broken, or whether there was a lack of understanding of a skill or concept. The process of domain specification development, reviews and revision resulted in a set of domain specifications within the three strands, rational numbers, numeration, and computation in grades three through six.

4.4 Summary

The purpose of this chapter was to report the process by which

Figure 13. Memo requesting review of a revised domain specification

TO: (Teacher Name)

FROM: Matthew M. Melillo

SUBJECT: Domain Specification #______

Thank you for your excellent review of the above domain specification. Enclosed are copies of the original domain specification, your review, and the revised domain specification. Please take a few moments to examine the revisions and comment on their appropriateness.

Thank you again for your cooperation.

instructional objectives were more clearly defined through amplification into domain specifications. The development of domain specifications is a prerequisite for developing items for criterion-referenced tests. Domain specifications provide clear targets for instructional specialists, and guidelines for item writers. The review process insures reasonable agreement concerning what is to be taught and what will be tested. Each domain specification was reviewed a minimum of three times and by a minimum of three teachers and two content specialists. The tight control exerted on the process insured the clear definition of the objectives as the investigation moves to the next step, the preparation of items.

The review and revision process resulted in an increase in the number of objectives. In Table 4 the number of objectives before and after review is reported. The review started with 79 domain specifications and ended with a total of 96. The 96 objectives represented in these domain specifications are listed in Appendix A. The 96 domain specifications were used by the item writers in the next phase of the project.

TABLE 4

NUMBER OF DOMAIN SPECIFICATIONS AFTER REVISION

	Elementary Operations		Numeration		Rational Numbers	
Grade	Pre-Review	Post-Review	Pre-Review	Post-Review	Pre-Review	Post-Review
3	9	9	3	3	5	5
4	11	11	6	6	5	5
5	13	14	8	8	1	4
6	10	16	4	2	4	10
TOTAL	43	50	21	19	15	27

CHAPTER V

DEVELOPING VALID ITEMS TO ESTABLISH CONTENT VALIDITY

5.1 Purpose

As discussed in Chapter IV the amplification of objectives and their clarification through review and revision resulted in a well defined set of domain specifications. The objectives defined the basic mathematics curriculum of interest to the staff and teachers. This chapter will report the procedures used to develop valid item banks to establish content validity.

5.2 Teacher Involvement

The involvement of teachers in developing valid items is an important prerequisite in establishing content validity. Their cummulative experience as instructional specialists is invaluable. Their input and feedback builds confidence in the domain specifications and the items. A secondary effect is that they ultimately will use the objectives to target instructional opportunities and the items to assess students' abilities.

The sections that follow will describe step-by-step the nature and sequence of teacher input in this study from item preparation, to item review, to field testing of the items.

5.3 Preparation of Items

The preparation of items, Step 4 in the Hambleton (1980) model, involved the following steps:

1. Three mathematics specialists were selected as item writers and revisers: the junior high school mathematics coordinator, an elementary teacher serving as a Title I mathematics specialist, and an elementary teacher hired on the CETA program

as a mathematics specialist.

2. Each item writer was assigned a sequence of domain specifications within a strand or strands in order that continuity of objectives and items be maintained.

3. Although creativity in writing items was encouraged, item writers were directed to cleave to the guidelines in each domain specification (refer to Figure 11, Chapter IV) and to develop items that were representative of the entire domain. This was to insure control and ease in item production.

4. Ten items were required for each objective, to be prepared on an item bank sheet. The item writers were also directed to prepare the alternative answers in ascending or descending order wherever possible. The item bank sheet included four sections - the domain specification number, an abbreviated form of the objective, one set of the directions to the student, and the ten items numbered consecutively after the domain specification number (e.g. domain specification number 5.01, item numbers 4.0101, 4.0102 . . . . 5.0110, 4.0111 . . . . 4.0115). An illustration of the layout (design) of the item bank sheet, including sample items, is provided in Figure 14.

5. Writers were also directed to provide an answer information sheet for the items in the bank. The information sheet included the following sections: the domain specification number, an abbreviated form of the objective, followed by a listing of the correct answer and short summary of each of the three distractors as illustrated in Figure 15. Its purpose was to expedite the review and editing because reviewers could easily find and check the correct answer and the distractors.

6. Since each item writer produced ten items per objective, and there were a total number of 96 objectives, 960 items were developed.

7. An item review form, based on a Hambleton design (1980) was developed to be used with classroom teachers in the validating phase of the study. Each writer individually piloted the form by reviewing samples of the others' works and then met with the investigator to discuss its usefullness in obtaining the three types of information to establish item validity.

5.4 Assessment of Content Validity

In criterion-referenced measurement, content validity is obtained by establishing the validity of each of the items in the domains - a

Figure 14. A sample item bank associated with a domain specification

Item Bank for Domain Specification #4.04

Item Bank Questions on Subtraction of Three or Four-Digit Whole Numbers

4.0401	4,015 - 499	a) 3,566	b) 3,576	c) 3,666	d) 4;464	4.0406	8,956 - 898	a) 9,854	b) 8,158	c) 8,068	d) 8,058
4.0402	4,024 - 246	a) 4,270	b) 3,878	c) 3,788	d) 3,778	4.0407	5,612 - 326	a) 5,286	b) 5,296	c) 5,386	d) 5,938
4.0403	4,340 - 948	a) 3,382	b) 3,392	c) 3,492	d) 5,288	4.0408	4,385 - 929	a) 5,314	b) 3,466	c) 3,456	d) 3,356
4.0404	3,932 - 943	a) 4,875	b) 3,089	c) 2,989	d) 2,979	4.0409	5,132 - 753	a) 4,369	b) 4,379	c) 4,479	d) 5,885
4.0405	7,217 - 908	a) 6,309	b) 6,319	c) 6,409	d) 8,125	4.0410	8,592 - 966	a) 9,558	b) 7,726	c) 7,636	d) 7,626

Figure 15. An answer information sheet for domain specification 4.04

4.04 <u>Subtraction of Three or Four Digit Whole Numbers</u>

	Correct Answer	Sum	Incorrect Regrouping In the Tens Column	Incorrect Regrouping In the Hundreds Column
1.	a	d	b	c
2.	d	a	c	b
3.	b	d	a	c
4.	c	a	d	b
5.	a	d	b	c
6.	d	a	c	b
7.	a	d	b	c
8.	c	a	b	d
9.	b	d	a	c
10.	d	a	c	b

procedure that involves a rigorous review of item characteristics. Three methods for reviewing test items were utilized in this investigation (Hambleton, 1980).

The first was the determination of item-objective congruence, i.e. estimating how well each test item assesses the content it is supposed to measure. In this investigation two procedures, one judgmental, the other statistical, were used for this determination. The second method of reviewing item characteristics was the determination of the technical quality of items. Two approaches were used to detect faulty items, again one judgmental, the other statistical. The third means of reviewing items was the assessment of item representativeness, a determination of how well the items represent the content defining the domain. These three methods for determining content validity are described and documented in the sections that follow.

Teacher Training in Item Review

A training session was held by the investigator with the teachers involved in the domain specifications review to present the background for the item review process. The meeting focused on the steps involved in the item validating process as exhibited in the item review form. Teachers were informed that they would be using their judgment in validating the test items.

They were each given a packet containing an item review form, instructions for completing the form, domain specifications and the ten items measuring each, and the answer information sheets to examine. Under the investigator's supervision materials were used to practice the procedures, discuss each of the technical questions and actually review a domain specification. The instructions for completing the item review form and the form itself are illustrated in Figures 16 and 17. The item review form was designed to provide three types of information as previously discussed:

1. Questions 1-10 focused on the technical characteristics of the test items.

2. Question 11 addressed the item-objective congruence.

3. Question 12 provided for an evaluation of how well item representativeness was addressed. An option for the teachers to present additional examples also was given.

Teacher Feedback on the Items

Each teacher was assigned an allocation of test items to review, the number of which varied from 130 to 200. Reference to Table 5 shows that assignments of items were overlapping - so that a least three teachers reviewed the same items. On-going verbal feedback during the review indicated that teachers;

1. re-examined the domain specifications for further input, and made additional changes,

2. felt that the training packet provided an excellent foundation for decision making, and

3. acknowledged their own growth in understanding the intent and process of item validation.

Following is a summary of written comments obtained from the item review forms submitted by the teachers for questions 1-10 (the technical quality of items):

1. The total number of item review forms returned was 291, with a duplicated count of 2910 total items reviewed.

2. Questions 4, 5, 6, 7 received the most comments, (Refer to the

Figure 16. Teacher instructions for completing the item review form

Instructions for Completing the Item Review Form

1. You will need a copy of a domain specification, the items written for it, the answer sheet, and an item review form.
2. Fill in the information requested on the review form.
3. Carefully read the domain specification.
4. Review each item and evaluate how well it corresponds to the required technical characteristics. Rate each item on characteristics 1 through 10.

   Use a Check Mark (✓) for yes Use an (X) for no Use an (O) for unsure
5. Technical Characteristic #11. Disregard any technical flaws which may exist in the test item (addressed by the first ten questions). Rate how well the content of the test item matches with some part of the content defined by the domain specification.

   Possible Ratings

   1 poor 2 fair 3 good 4 very good 5 excellent
6. Write any comment in the space next to the item on the item sheet and place a check (✓) in the appropriate space of the item review form.
7. Repeat steps 1-12 for each item.
8. Clip together the item review form, the item sheet, answer key and the domain specification and send to Mr. Melillo as soon as completed.

Figure 17. Item review form

Item Review Form - Multiple Choice Questions

Domain Specification Number ____________ Reviewer ______________________ Date __________

Rating Key - Check (✓) - yes (X) - no (O) - unsure

Technical Characteristics	Item Bank Numbers 01	02	03	04	05	06	07	08	09	10
1. Is the item stem clearly written for the intended group of students?										
2. Is the item stem (the statement) free of irrelevant material?										
3. Is a single problem clearly defined in the item stem?										
4. Are the answer choices free of irrelevant material?										
5. Is there a correct answer or clearly best answer? If not correct on the item sheet.										
6. Are likely student mistakes used to prepare the distractors (incorrect answers)?										
7. Are the answer choices arranged in a logical sequence (if one exists)?										
8. Do the item stem and answer choices follow standard rules of punctuation and grammar?										
9. Are all negatives underlined?										
10. Are expressions like "Which of the following is not" been avoided?										
11. General rating of how the content of the test item matches that defined in the domain specification. 1-poor 2-fair 3-good 4-very good 5-excellent										
12. Indicate that a comment is written next to the item by placing a check (✓) in the space provided. Correct or add items that better represent the objective.										

TABLE 5

ALLOCATION OF TEST ITEM SETS TO REVIEWERS

Teacher	Grade	Test Item Sets
1	3	1-13
2	3	1-9, 14-17
3	3	1-5, 10-17
4	3	1, 6-17
1	4	1-16
2	4	1-11, 17-22
3	4	1-6, 12a-22
4	4	7-22
1	5	1-15
2	5	1-5, 16-25
3	5	6-20
4	5	1-10, 21-25
5	5	11a-25
1	6	1-11b
2	6	1-5b, 12-21
3	6	6-19
4	6	1-11b, 20-21

item review form in Figure 17 on page 66.

3. In response to question 4 the teachers commented on the appropriateness of illustrations or how choices did not match the response section of the domain specifications.

4. Question 5 elicited interesting responses. One teacher in each of grades three and five and two teachers in grades four and six did all the problems and checked all the answers to each item even though an answer information sheet was provided.

5. Seven teachers responded to question 6 by suggesting additional distractors.

6. Several teachers called attention to patterns in the answers in the answer bank when replying to question 7. For example, on the answer information sheet for domain specification 6.13 the pattern of correct answers was a, b, b, a, b, ... The teachers were informed that the items would not be presented in the same sequence on any test. The more valuable comments were those that indicated that the correct answer was always in the same location in the alternatives.

Teacher's ratings in question 11 on the item review form were important to the revision team in establishing item-objective congruence. The following procedure was used by the team:

1. When all three reviewing teachers rated an item and it received an average score of 4.0 or 5.0 no revision was undertaken.

2. If the average rating was about 3.0 the revision team referred to the item bank sheet for teacher comments, corrections, and substitute items, highlighting the importance of question 12 on the form. The combination of replies to questions 11 and 12 were invaluable in the revision process. In 70% of the items receiving 3.0 ratings, the teachers either modified the item or suggested new items.

3. A review of the items with average ratings of 2.0 or below indicated that they exceeded the range of content or skills defined by the objectives. This resulted in one of a number of revisions: completely eliminating a domain specification; splitting the domain in two or creating a new domain specification.

Thus the revisions were completed from the judgmental review and the items were ready (readied) for field testing.

Preparation of Tests and Field Testing

The question of how to best assemble the 960 items into tests for field testing was the next consideration. Problems such as test length, number of items per test, number of test forms, randomization of items, preparation of test booklets, teacher and student directions, the number of possible responses per item, answer forms, scoring keys, preparation of tests for computer scoring and finally, faculty meetings had to be resolved.

It was decided to prepare tests in four forms for each grade level and the number of items per test (i.e. test length) as so indicated in Table 6. Distributing the items in this manner for each test would result in a minimum of 65 student responses per item, require less than an hour to administer and provide a sufficient number of test forms for randomizing items.

It was decided to split the ten items from each domain specification in half and place the five item sets into different test forms. The five item sets were vertically placed on either a whole or half page under their domain specification number and a code indicating their item bank number. A master list of domain specification numbers and item codes was prepared for each form, and then the tests were typed, proof read by two content specialists and duplicated. A sample copy of one test form (4.2) is located in Appendix C.

Prior to field testing, a number of written materials were prepared:

1. a teacher information sheet (see Figure 18) which indicated the purpose of the tests, how to establish randomization,

TABLE 6

NUMBER OF TEST ITEMS IN EACH TEST FORM

Grade	Number of Objectives	Test Form 1	2	3	4
3	17	45	45	40	40
4	25	60	65	60	65
5	26	60	60	55	55
6	28	60	60	60	60

Figure 18. Teacher directions for test administration

TO: All Third through Sixth Grade Teachers

FROM: Matthew M. Melillo

SUBJECT: Tests of Item Validity

There are four forms of each test to be given in each class on each grade. Although, the tests might differ in length the items have been randomized to fulfill a validity requirement. In order to meet another condition of randomization, just pass out the tests in the order in which they are stacked.

Please make sure you read the directions to the students. Feel free to interpret the directions to help your class understand and complete the task. The teacher packet should include:

30 Tests - All Forms N.1 - N.4   4 Extra Answer Sheets
1 Teacher's directions to the class   1 Absentee Form

General Preparation and Considerations

1. All students should use a pencil with an eraser. No Calculators!

2. Students may use any space for scrap on the test, either in the problem space or the back of any page.

3. This is not a timed test, so please allow enough time for all students to finish.

4. Maintain a test-taking atmosphere in the classroom.

5. When testing is completed pack the answer sheets and tests and deliver to the Title I Math Teacher.

6. Submit the list of absentees with the pack of answer sheets and tests.

7. Alert the students to the fact that the tests vary in length and not be confused by the answer sheet. Following are the various test lengths by grade.

	Grade 3	Grade 4	Grade 5	Grade 6
Number of Problems-	40 or 45	60 or 65	55 or 60	60

Thank you for your cooperation in this important project.

conditions under which the tests were to be administered, and how the data should be returned.

2. a direction sheet to be read to students (see Figure 19) and

3. an answer sheet with a sample item. The answer sheet was designed with the assistance of a computer consultant for ease of reading by a key punch operator. The items were blocked into groups of five (see Figure 20). The answer sheet included a form number that corresponded to the test form number to which it was attached, directions for the student including a sample problem and the answer sheet marking procedure.

A meeting was held with the principals of the three elementary schools where the tests were to be administered. They were presented drafts of directions to the teacher, teacher directions to students, student directions, and an answer sheet for their comments and suggestions. A background information sheet was prepared for the principals' use at faculty meetings to be held in preparation for the testing. The information on this sheet was also discussed (see Appendix D). The principals' roles were to establish the testing schedule, direct the faculty meetings, discuss the reason for testing, explain the logistics, notify the teachers that the elementary mathematics specialists would be available to answer questions, coordinate the testing and collect all materials upon completion. After the principals had made their suggestions and revisions were made, a meeting was held with the two elementary mathematics specialists to discuss their roles in the field testing:

1. be familiar about all aspects of the field test,

2. be present in the building during the testing to answer teacher questions,

3. collect and sort the answer sheets and test booklets,

Figure 19. Teacher directions for students

Directions to be read at the Beginning of Testing

Introduction

"This is not a test. It is an experiment to see how many problems you can do. The results have nothing to do with your class mark, so try to do every problem. You will have as much time as you need to finish. You may use any space on the test for scrap paper."

The Heading

"Now take your test and the answer sheet. Remove the answer sheet from the test. Be careful not to rip the answer sheet. Now look at the upper left hand corner of the test. You will see the word FORM and then a number. Make sure the number on the test matches the form number on the answer sheet."

(Demonstrate by pointing to the appropriate places on the test and the answer sheet.)

"Now print your name on the top of the test and on the answer sheet."

Answer Sheet Directions

"Read all problems carefully and choose the correct answer. Circle the letter of the correct answer next to the problem number on the answer sheet. Be careful to make sure you circle the answer next to the number of the problem you are answering." (Refer to the example on the answer sheet.) "Circle only one answer for each problem. If you wish to change your answer, be sure to erase the first mark completely. If you have any questions once you start, put up your hand and I'll come to your seat to answer your questions."

Figure 20. Student answer sheet

FORM # 4.2 STUDENT NAME______________________________ SCHOOL: C W S

Answer Sheet

Read all problems carefully and choose the correct answer. Circle the letter of the correct answer next to the problem number on the answer sheet. Make sure you circle the answer next to the number of the problem you are answering. Circle only one answer for each problem. If you change your answer be sure to erase the first mark completely.

Example: 76. $\begin{array}{r} 28 \\ +\ 13 \\ \hline \end{array}$ a) 15 c) 41 b) 31 d) 45 76. a b c d

1. a b c d	21. a b c d	41. a b c d	61. a b c d
2. a b c d	22. a b c d	42. a b c d	62. a b c d
3. a b c d	23. a b c d	43. a b c d	63. a b c d
4. a b c d	24. a b c d	44. a b c d	64. a b c d
5. a b c d	25. a b c d	45. a b c d	65. a b c d
6. a b c d	26. a b c d	46. a b c d	
7. a b c d	27. a b c d	47. a b c d	
8. a b c d	28. a b c d	48. a b c d	
9. a b c d	29. a b c d	49. a b c d	
10. a b c d	30. a b c d	50. a b c d	
11. a b c d	31. a b c d	51. a b c d	
12. a b c d	32. a b c d	52. a b c d	
13. a b c d	33. a b c d	53. a b c d	
14. a b c d	34. a b c d	54. a b c d	
15. a b c d	35. a b c d	55. a b c d	
16. a b c d	36. a b c d	56. a b c d	
17. a b c d	37. a b c d	57. a b c d	
18. a b c d	38. a b c d	58. a b c d	
19. a b c d	39. a b c d	59. a b c d	
20. a b c d	40. a b c d	60. a b c d	

4. collect the list of absentees, and

5. forward all materials to the investigator.

Testing packets of teacher materials were assembled for the faculty meetings and forwarded to the principals. The contents are described in the directions to the teachers in Figure 18. Special care was taken to randomly distribute the different test forms within each class package. All classes received a minimum of six of each of the four test forms, randomly sequenced. The teacher directions directed that the tests be distributed in the order received. The numbers of classes tested in each school are listed in Table 7.

No serious problems were observed during the test administration. Principals and mathematics specialists reported that the teachers exercised good judgment in providing a proper test environment. Students who experienced frustration were excused from completing the test.

The minimum number of students taking any form of the test was 68. Table 8 lists the number of students in each school who took the various forms of each test, and the total number of students responding to each form. Several items were found to be flawed: item 24 in test 3.3, item 22 in test 3.4, item 41 and 63 in test form 4.2, item 21 in test form 5.4, item 55 in test form 6.1, and items 3 and 11 in test form 6.3.

Item Analytic Data

In this study the item analytic data were primarily used to detect flawed items. The following sections address the process of locating aberrant items by describing the data presented in the computer print-

TABLE 7

NUMBER OF CLASSES TESTED

Grade	School 1	2	3	Total
3	4	5	4	13
4	5	4	4	13
5	4	4	3	11
6	5	3	3	11

TABLE 8

NUMBER OF STUDENTS RESPONDING TO EACH FORM

Grade	Test Form	School 1	2	3	Total
3	1	24	27	21	72
	2	26	28	20	74
	3	27	29	20	76
	4	25	29	20	74
4	1	30	26	21	77
	2	28	23	23	74
	3	30	24	22	76
	4	28	21	22	71
5	1	28	25	19	72
	2	27	26	17	70
	3	24	25	19	68
	4	27	26	18	71
6	1	32	18	22	72
	2	29	19	22	70
	3	31	20	21	72
	4	29	19	21	69

out, the procedures used for combining and reviewing the data, and then examples of flawed items.

A. The Print-Out. The print-out for each item on every test form followed the format illustrated in Figure 21. The sample is taken from item 38 on test form 3.2. A description of the print-out is also included in the Figure.

B. Reviewing the Item Data. In order to simplify the review of the item statistics an item statistics summary sheet was developed. The item data for each item referencing an objective was transferred from the print-outs to this form. Figure 22 illustrates the summarizing of the item statistic information for the 10 items measuring domain specification number 3.13. The search for flawed items started with a review of the summarized item statistics for each objective.

When used in criterion-referenced measures all the items referencing an objective should elicit similar responses from examinees. Item homogeneity is essential because test developers must be able to randomly select items representing an objective and have the confidence that student responses to those selected can be generalized to the entire set (Popham, 1978, Hambleton, 1980). This is the major reason why flawed items must be found and corrected.

The difficulty level and discrimination index are data that are used to detect aberrant or atypical items. Additional item analysis data are available to help detect flawed items, namely, the data on distractors and the alternative answers selected by high and low scoring students. Following are descriptions and examples of how the above

Figure 21. Sample item analysis print-out of item 38 on test form 3.2

Item Number	(A) Percent Correct For Students Who Attempted Item	(B) Percent Correct For All Students	(C) r Biserial With Total Score
38	.8750	.8514	.7393

(D) Quarter	(E) Not Reached	(F) Omitted	(G) Number Of Students Answering Each Alternative By Quarter 1	2	3	4	5	(H) Total
1	0	0	1	17	0	0	0	18
2	0	0	0	18	0	0	0	18
3	0	0	0	17	1	1	0	19
4	2	1	2	11	1	2	0	19
5	2	1	3	63	2	3	0	74

(A) The percent correct for students who attempted the item. This number represents the number of students who correctly answered the item (63) divided by those who attempted it (71).

(B) The percent correct for all students. This number is calculated by dividing the number of students who correctly answered the item (63) by those who took this form of the test (74). This statistic is useful when it is reasonable to assume that those students who did not reach, or omitted the item, would answer it incorrectly. This statistic is referred to as the item difficulty level or p-value.

(C) r Biserial with the total score. It is an index of how the item discriminates between high-scoring students and low-scoring students on the test form. This statistic is called the discriminating index, the discriminating power of an item, or the r_{bis}.

(D) Quarter. In the column under quarter the numbers 1 through 4 represent the quartile division of all examinees from highest scoring (1) to lowest (4). The number 5 represents the total of each column when read horizontally under columns (E), (F), (G), and (H).

Figure 21. Continued

(E) Not Reached. Column (E), not reached, presents the number of students in each quartile who did not reach this item.

(F) Omitted. The number of students in each quartile who omitted this item are listed under column (F).

(G) Number of students answering each alternative by quarter. Each test consisted of multiple choice questions with either two or four alternative answers. Columns (1) through (4) represent each of the possible answers. The number of responses are presented by student quartile in each column. The total responses for each alternative answer are listed in the last row of each column.

(H) Total. The total column (H) presents the total number of examinees from each quartile who either did not reach the item, omitted the item, or selected one of the alternative responses. The last row in the column is the total number of students who were administered the item.

Figure 22. Item statistics summary sheet

Domain Specification No. 3.13

Test Form	Questions	Item	Difficulty Level	Discrimination Index	Total Responses on Alternative Answers ●-Correct Answer				High (1)/Low (4) Group Spread on Alternative Ans.				Difference Between High-Low Scores
					1	2	3	4	1	2	3	4	
3.1	36	1	.94	.72	69●	3	1	0	18/16	/2	/1	/	2
	37	2	.88	.79	64●	4	4	1	18/12	/4	/2	/1	6
	38	3	.88	.84	1	5	3	64●	/	/4	/3	18/12	6
	39	4	.88	.91	5	2	64●	2	/4	/2	18/11	/2	7
	40	5	.88	.99	1	64●	4	2	/1	18/11	/4	/1	7
3.2	36	6	.76	.69	5	5	5	56●	/2	1/3	/2	17/9	8
	37	7	.80	.38	6	2	59●	4	/1	/1	18/4	/	14
	38	8	.85	.74	3	63●	2	3	1/2	17/11	/1	/2	6
	39	9	.78	.44	58●	7	1	4	17/12	1/2	/	/2	6
	40	10	.85	.72	2	3	2	63●	/1	/2	/1	18/11	7

data were used to establish content validity.

The difficulty level, (p-value) for an item is the ratio of the number of examinees who correctly respond to the total number of examinees who attempted it. The difficulty level is measured on a scale of .00 to 1.00. The p-value data for items measuring a common objective can be studied to identify items with p-values that are not in line with the rest (too high or too low). These items are studied to determine if there are flaws.

The discrimination index, (r-value) or discrimination power of an item is a mathematical means of stating the extent to which an item discriminates between the low and high scoring examinees on the total test. Items with very low or negative r-values indicate a problem. The higher the index the greater the discrimination power of the item.

The combination of the difficulty level and the discrimination index are very useful in detecting potentially flawed items, miskeys, no answer or multiple correct answers.

The spread and number of responses among the alternative answers indicates how the distractors are working. This spread of responses in combination with the difficulty level and/or discrimination index can indicate miskeys, no correct answer, multiple answers, and poor distractors

The number of students who select the correct answer, and the distractors, from the high scoring and low scoring groups of students is also helpful in correcting items.

No matter which of the item statistics is used to indicate a problem with an item, the actual items and domain specifications must be reviewed before item corrections can be made. Following are several examples, taken from the item data generated as part of this study that underscore the use of empirical methods to find and correct flawed items.

Examples of Flawed Items. An example of "no correct answer" was item number 55 from test form 6.1. The question was:

55. Another name for the fraction $\frac{1}{8}$, is the decimal ______.

a) .180 c) .700

b) .180 d) .810

A review of the item statistics indicated a low p-value and negative r-value for item 55:

Item Number	51	52	53	54	55
p-value	.51	.39	.42	.38	.10
r-value	.70	.82	.83	.90	-.15

Another example of a flawed item - a miskey - was found in item number 8 in objective (domain specification) 3.09. The p-values ranged from .09 (item number 8) to .79 with the p's for all the other items clustering in the .62 to .79 range. The r-values for all other items in domain specification 3.09 ranged from .52 to .95. Item number 8 had an r-value of -.61.

In domain specification 3.06 item 10 had a considerably lower p-value (.47) than the other nine which ranged from .78 to .94. A review of the item bank also indicated that there were only two problems requiring the addition of three, 3-digit numbers. Of the two, item 10 required regrouping from the ones to the tens and from the tens to the one hundreds. Although this item fitted within the content limits of the domain it did not behavior statistically like the others. This indicated that either the objective was too broadly defined, and the number of regroupings should be included in the objective and the content section of the domain specification, or, that more items similar to number ten should be developed for the objective.

In domain specification 5.22 it appeared that item number 9 was easier than the rest of the items. It had a p-value of .77. The p-values of the other nine items clustered in the .46 to .57 range:

Item Number	1	2	3	4	5	6	7	8	9	10
p-value	.46	.50	.50	.54	.49	.54	.54	.57	.77	.59

The objective for domain specification 5.22 was:

> Given a verbal decimal problem to the thousandths place, the student will be able to select the correct numerical equivalent.

Further review of the item pool for domain specification 5.22 indicated that seven of the ten items dealt with decimals to the thousandths place. Three of the items required students to work in the hundredths place. Of these three, two required answers in the hundredths place only, whereas the item in question required working with a very common decimal in the tens and hundredths place (.25). It appeared that item number 9 should be revised or that more items with the same characteristics of number 9 should be developed.

Distractors can be improved by examining the item statistics. For example the p-value range in domain specification 6.10B was from .28 to .61. Nine of the item p-values were between .28 to .51. The item difficulty level for item 6 was .61. An examination of the spread of selections among the alternative response of item number 6 revealed that few students selected either 1 or 4:

Spread of Responses Among Alternative Answers				
Item Number	1	2	3	4
6	3	17	44	1
7	8	10	37	12
8	12	12	33	9
9	8	30	19	9
10	9	12	32	13

Item 6 is shown below:

6. (-12) + (5) =	
a) 19	c) -7
b) 7	d) -19

It is clear that alternative answers in a) and d) were incorrect and should have been positive (17) and negative (-17) totals of the two numerals in the stem.

Examples of Domain Specification Problems and Their Revision. Of the 960 items, 936 required no revision as a result of the review of item response data. This was attributed to the tight control exerted on the development, review, and revision of the domain specifications and the items, and the narrowness of the basic mathematical objectives. But the item response data revealed another problem not apparent in all previous judgmental reviews and revisions. Namely, the item response data seemed to indicate that several domain specifications were too broadly defined. Following are examples of domain specifications that fall into that category.

A review of the data from domain specification 6.10A revealed a p-value range of .51 to .81 which seemed to indicate too wide a spread. Upon closer examination it became apparent that the items separated into two subsets: items 1, 3, 4, 5, 6 had a p-value range of .51 to .60, and, items 2, 7, 8, 9, 10 had a p-value range of .76 to .81. Further review of the ten items revealed that there were two distinct subsets: one in which the numerals in the item stem were both negative, the other in which they were both positive. For example:

$$(-7) + (-13) = \text{ and } (+11) + (+6) =$$

The higher p-value items were those with positive numerals.

The objective for 6.10A stated: "Given a pair of integers having like signs, the student will be able to find the sum". The objective was simply stated but apparently was too broad in its content description. Either the domain specification has to be split into two - one for negative and one for positive integers, or two subsets of items should be written in order that a random sampling of items can be used in test assembly. The previous, single set can not yield item data from which consistent instructional decisions can be made.

In domain specification 4.08 the p-values of items 1 to 5 were distinctly different from the p-values of items 6 to 10:

Item Number	1	2	3	4	5	6	7	8	9	10
p-values	.98	.100	.93	.97	.96	.76	.62	.80	.61	.65

A review of the items in the bank revealed that the first five items required multiplication skills using numerals from 4 to 9. Whereas, the last five items required multiplication skills with numerals 10 to 12. This review indicated that domain specification 4.08 could be split into two; one with the lower limits of content, the other with the greater.

The item response data from items in domain specification 4.17 presented another problem. The p-value range for the ten items appeared to be too broad (.35 to .74). Upon closer examination a pattern emerged. The p-value range of the odd numbered items was .35 to .41 and the even numbered items .55 to .74. A review of the items revealed that the alternative answers for the odd items were in ascending order, and, the alternative answers for the even numbered items were in descending order. For example:

<u>Ascending Order</u>	<u>Descending Order</u>
Which expanded numeral equals: 59,876?	Which expanded numeral equals: 98,765?
a) 5,000 + 9,000 + 8 + 70 + 60	a) 90,000 + 8,000 + 700 + 60 + 5
b) 5,000 + 9,000 + 800 + 70 + 6	b) 90,000 + 8,000 + 7 + 60 + 500
c) 50,000 + 9,000 + 8 + 70 + 600	c) 9,000 + 8,000 + 700 + 60 + 5
d) 50,000 + 9,000 + 800 + 70 + 6	d) 9,000 + 8,000 + 7 + 60 + 500

The content in all the items was in the ten thousands so apparently this did not affect student responses. It was surmised that the order of the alternative responses, ascending or descending, affected student selection. This issue was considered during revisions.

This completes the description of how item response data were used to detect flawed items and faulty domain specifications. The examples discussed were characteristic of the types encountered in the review of the item response data. The item data will be useful when preparing tests in the future. Individual item statistics can be used to select item for assembling mastery tests (Hambleton, 1980).

Content specialists made the appropriate revisions in the flawed items. Several domain specifications required simple adjustments in the objective, content and response sections. Major revisions or redevelopment require repeating the review and revision steps previously described for domain specifications and items.

5.5 Summary and Conclusions

This chapter reported on the procedures used to develop valid item pools in establishing content validity. The procedures involved were:

1. teacher participation in item preparation and item validation on a judgmental level,

2. preparation of tests based on teacher feedback,

3. field testing in regular classes by participating teachers,

4. the statistical validation of items, and

5. their subsequent effect on the improvement of specific items and domain specifications.

The conditions for establishing content validity (Hambleton, 1980) by determining item validities, technical quality, and item representativeness were satisfied. The procedures used to establish valid item sets were a critical prerequisite for continuation of the steps in building criterion-referenced tests. It was concluded that the work of the project could proceed with confidence since the items measured the basic mathematics objectives, and the tests constructed with these items would yield useful instructional information.

It was at this point that the partial implementation of the model terminated and that the purposes of this study were considered to have been accomplished. The continuation of the implementation of the model will be discussed in Chapter VI.

CHAPTER VI

CONCLUSIONS AND SUGGESTIONS FOR ADDITIONAL RESEARCH

6.1 Scope of the Study

This investigation focused upon the implementation of two key components of a model for the design and implementation of objectives-based programs. In the curriculum component, instructional objectives were developed to define a basic elementary mathematics program. This was followed by a more clear definition of the objectives by amplifying them into domain specifications. In the evaluative component, items were developed from domain specifications and validated through a series of reviews and revisions. Content and instructional specialists were involved in the development, review and revision of the domain specifications and items during the implementation. The judgmental and item analytic processes utilized to determine content validity were described and documented in Chapters IV and V.

The implementation of the evaluative component will continue using the validated items to construct criterion-referenced measures. The test assembly process will follow the remaining steps in Hambleton (1980) as discussed in Chapter III.

The steps included in the instructional component were not implemented but recommendations and suggestions for further development and research will also be presented in section 6.2.

6.2 Continuation of the Investigation

Evaluative Component

The remainder of the steps in building a criterion-referenced test

(Hambleton, 1980) will be implemented during the 1980-81 school year. A validated item bank will serve as a resource for developing several types of criterion-referenced measures. First among these is a placement test which will be used to determine the status of each student in grades 3 through 6, in relation to the basic objectives designated for that grade. The number of objectives located on each grade, even after revisions brought about by the item analytic review, is manageable. The maximum number of objectives to be tested on any grade is 28.

It would be preferable to make up a test using all ten items for each objective. The experience of the field test indicates that this could be accomplished in two test administrations of less than an hour each. The purposes of such lengthy tests is two-fold. First, it obviates the need for rigorous standard-setting procedures if the cut-off score that differentiates masters from non-masters is 7 or 8 out of 10 on each objective. Second, the tests will provide additional data for the continuous analysis of item validity and reliability. Although this might seem inefficient, it does have intuitive appeal and reinforces teacher confidence in the items. In addition, the subscores on the items representing each objective can be used to develop a diagnostic profile for each student. Tests of retention of skills will also be constructed because of the need to demonstrate student retention of mastery over time. The fourth test, a posttest, will be used to measure student progress when the scores are compared to the scores from the preassessment. This analysis will assist in the evaluation of the program and the continuous collection of data on reliability and validity.

Instructional Component

The instructional component will commence with the communication of the program goals, embodied in the objectives, to the instructional staff, followed by the administration of the placement test signaling the start of the instructional implementation. Several of the needs and problems of the instructional implementation will be addressed by developing a change plan. The strategies included in the plan are adopted from considerations in planning change in Browder (1973), and Hersey and Blanchard (1972). They provide the background for the implementation of the instructional component:

1. Staffs in school districts tend to resist change.
2. Any change plan must be incorporated into the operation of the program.
3. The goal is not merely to create a change but to create a change that leads to improved education and student gains.
4. The ultimate decision to change or not to change is controlled by the staff being changed.
5. The change is real only when incorporated into classroom practice.
6. The plan must provide for diverse and representative forms of participation.
7. The plan must include a training component for all participants.
8. The plan must define the roles and responsibilities of each staff member participating.

Following is a brief description of the steps followed in the partial implementation and the plans for its future continuation.

<u>Stage I</u> - <u>Preliminary Planning</u>. The work of developing an initial definition and acceptance of the general program objectives among the administrators, Board of Education, and content specialists, and the description of administrative roles in presenting the general program objectives to the staff.

<u>Stage II</u> - <u>Formal Planning and Development</u>. This was the work accomplished by the development team of content specialists during the private phase. They developed a content matrix and a bank of objectives that circumscribed the universe of basic elementary mathematics. The objectives were more clearly defined through amplification into domain specifications. The specialists then used the domain specifications to develop a preliminary set of items for each objective. The objectives, domain specifications, and items developed during the development stage were used during the next phase, the public phase.

In this phase, the instructional staff was involved in the review of the products of the development team. The general program objectives were communicated to the staff for their reactions. The schedule of steps, the teacher roles, and the rationale for each were presented at the first meeting. The content specialists and teachers reviewed the domain specifications and revisions were completed.

The purpose and procedures for validating items were described. The staff participated in the judgmental review of items, which were then field tested. Item analytic data were used to detect and correct flawed items and faulty domain specifications.

The development team will assemble tests from the revised and validated item pool. Teachers will administer the tests. They will be scored, analyzed and returned to the teachers informing them of the status of their students, and the implications for instruction.

<u>Stage III</u> - <u>Instructional Implementation</u>. The instructional implementation stage will commence with the use of the preassessment data to make decisions concerning the various instructional needs of the students in each class in grades 3-6. The objective of this stage is to provide each participating teacher individual support and inservice in their personal program implementation. This critical implementation strategy is the "treatment" required to insure a teacher growth and program success. This important aspect of aligning expectations of teacher performance and the program goals deserves special attention and will be elaborated on later. No two teachers will exhibit the same readiness, style, management abilities, or understanding of the general program objectives. The essence then, of this stage, is the facilitating behavior of the project directors and administrators in helping teachers implement the model in their indi-

vidual classrooms. It is at this stage that the curriculum, instructional, and evaluative components of the model are brought together for program and instructional improvement to achieve program objectives and promote student learning. These processes will be formatively evaluated throughout the implementation in order to provide data for reactive improvement of any segment of the model.

Stage IV - Summative Evaluation and Reporting. The first year of implementation ends with the administration of post-assessment, criterion-referenced tests and the gathering of additional data for outcome analysis and interpretation of program success. A variety of measurement strategies (tests, questionnaires, and surveys, attitude scales, interviews, observations and unobtrusive measures) will be used to gather data from a variety of sources. These data will be combined to report the relationship between the actual and ideal student outcomes and the results of the implementation of the model. This will be followed by making adjustments in the model for the second year of the implementation.

6.3 Teacher Performance

In order to further clarify the importance of aligning teacher performance expectations and the characteristics of objectives-based programs, Table 9 is presented as a prerequisite to the implementation of the supervisory and inservice aspects of an objectives-based program. Millman summarizes the interrelationship between instruction, curriculum, and evaluation by relating them to teacher performance in objectives-based programs. He states:

> Perhaps the most important skill of a teacher is the ability to bring about changes in the behavior of students on prespecified objectives. When student behavior is measured on DRT's (CRT's) the desired student behavior becomes explicit. The precise boundaries of behavior to be assessed are defined, and criteria for judging the adequacy of learner responses are identified. (Millman, 1974, p. 392)

Teacher behavior is the most important variable in the success of objectives-based programs.

6.4 Revisions of Investigation Procedures

TABLE 9

TEACHER PERFORMANCE EXPECTATIONS

Six Basic Components of Objective-Based Programs[1]	Teacher Performance Expectations Basic Educational Program
1. The goals of learning are stated in terms of observable student behavior.	1. a. Teachers should contribute to determining the goals of the program.
	1. b. Teachers serve a team that translates goals into instructional objectives.
2. When the student begins a particular instructional program, his initial capabilities, those relevant to forth coming instruction, are assessed.	2. a. Teachers contribute to validation of the items by performing judgmental operations and administer response checks and help analyze the data.
	2. b. Teachers should administer tasks that help analyze the performance of each student relative to the domains of interest with a pretest. Each student's level of functioning should be established.
3. Educational resources matched to the students initial capabilities are presented to him. The student selects or is assigned one of these alternatives.	3. a. Each teacher must develop a program plan, instructional sequence, for each student based upon assessment results.
	3. b. Teacher must select/develop appropriate learning opportunities and organizing centers to instruct each student in the needs diagnosed.
4. The student's performance is monitored and continuously assessed as he learns.	4. a. The teachers must maintain concurrent records of each child's progress through the program. Special note should be made of each child's rate, strengths and weaknesses.

TABLE 9-Continued

	4. b. Teachers should seek help from support staff to assist with determining needs of students who fail to show progress.
5. Instruction proceeds as a function of the relationship between measures of student performance, available instructional resources, and criteria of competence.	5. a. Teacher must maintain a learning environment that is sensitive and reactive to students' instructional needs.
	5. b. Teachers must use a variety of tasks, including tests, to informally asses student progress.
	5. c. Teacher must have mastery of content and ability to present alternative learning opportunities.
	5. d. Teacher must use reliable and valid measures to determine mastery.
6. As instruction proceeds, data are generated for monitoring and improving the instructional system.	6. a. Teacher must examine objectives, learning opportunities, organizing centers, and assessment tasks for faults and/or inconsistencies.
	6. b. Teacher must report inconsistencies in any of the instructional components in order to make improvements.

[1]See Hambleton and Rovinelli (1973, pp. 9-10).

This section of the chapter will address revisions suggested in the procedures used during the investigation.

Number of Teachers Involved in the Review

There were too few teachers to review the domain specifications and items. Another problem was that the teachers performed the reviews on their own time. There were no arrangements made for compensation. This caused an extension of the schedule since the return of the reviews took much longer than planned. If any teacher had too many reviews, they may also have had many revisions to re-review. The need for an additional review of revisions only compounded the problem of time.

Revision of the Forms

Question 1 in the skill section of the domain specification review form should be revised to speed up the review. It should read:

1. Can the skill section be revised to improve its clarity?

   Yes. Please write the revision on the domain specification sheet.

   No. The skill section is clearly written.

In the content section of the same form question 5 should be revised to read:

5. Do you have any suggestions for revising or extending the content defined by the skill? Please write your comments directly on the domain specification sheet.

   The content limits are too broad for the intended group.

   The content limits are too narrow for the intended group.

   The content is just right for the intended group.

Question 12 on the item review form could be split into a question and a request. The new question should get more directly at the issue of <u>item representativeness</u> by asking:

> Does this item represent one that falls within the limits described in the skill and content sections?

The purpose of the requests is to reinforce the replies to this new question. It should prompt reviewers to analyze whether the items fall within the appropriate limits of the domain referenced by the domain specification. It requests the reviewer to:

> Examine <u>all</u> the items presented.
> Do they represent tasks that fully define the content presented in the objective?

<u>Rating of Objectives or Domain Specifications</u>

The skills in a basic elementary mathematics program are clearcut and easy to target. In this investigation the content specialists defined the universe of basic mathematics by developing the content strands and the objectives. Classroom teachers were not directly involved in either the selection, development, or rating of the objectives. They were indirectly involved when judging the appropriateness of the objective to the grade level in their responses to the questions on the domain specification and item review forms. A problem of specificity is created by examining how well the instructional objectives communicate instructional intent and imply assessment tasks. This is especially true if the number of objectives are to be kept to a minimum by defining several days of instruction. If the objectives were to include all content and response conditions, the number required in the curriculum would be unwieldy. If they are too general they would reference a wide variety of content and behaviors which would neither serve as instructional targets nor the basis for developing assessment tasks.

It appears that the procedures should be revised in two ways. First, classroom teachers should be involved in the determination of the content matrix and the selection of the objectives that represent the program goals. Second, the teachers would rate the objectives to be included or not included in the basic program. In order to make the rating of objectives meaningful, examples of the content should be included. This expanded form of objective is illustrated in Figure 23. It presents more information than an objective but less than a domain specification.

Please note that in the two examples both the instructional objective and three samples of the content are provided in the items. The items define three different samples of the content referenced by the domain. They represent the lower, middle, and upper ranges of difficulty. This format should help raters judge the appropriateness of the objective.

Number of Items

It was not until the judgmental review of items by teachers that it became apparent that more items should have been produced initially. They would provide greater flexibility and better domain coverage. In the context of this study 15 or 20 items per objective would have been better. But for other studies it depends on the breadth of the objectives, the number of different ways the items are going to be used, and the quality of the items. In this study the items will be used a number of different ways so more are needed. They will be used to

Figure 23. Expanded form of objective for teacher rating

Given three dicimals to the hundredths place, the student will be able to find the sum.

$$.34 + .20 + .13 =$$

$$2.60 + 5.42 + 1.18 =$$

$$16.53 + 3.45 + 11.87 =$$

Given a three-digit and a two-digit whole number the student will be able to find the product using a standard multiplication algorithm.

$$\begin{array}{r} 198 \\ \times\ 35 \\ \hline \end{array} \qquad \begin{array}{r} 482 \\ \times\ 63 \\ \hline \end{array} \qquad \begin{array}{r} 796 \\ \times\ 85 \\ \hline \end{array}$$

assemble a variety of tests; pre and post, parallel forms, diagnostic, and retention of skills tests. Starting with twenty items might be more efficient because of the coverage, item representativeness range within each domain, and the ease with which flawed items could be discarded without difficult and time-consuming revisions.

Filing and Dating

Extraordinary amounts of data are developed in a project of this kind. Domain specifications, items, and the review forms present possible problems of loss of sequence in the many reviews and revisions. Better anticipation of these problems would have resulted in the dating of all forms and the construction of a more flexible numbering system.

6.5 Additional Research and Development

There are several promising lines of research and development that follow from the project. Each will be discussed briefly.

Continued development in structuring domain specifications is necessary. Several questions should be considered: Are current categories sufficient for developing domain specifications? Should a separate section address item representativeness? Are there alternative means for developing domain specifications?

More must be done in the development of objectives. What is the best format for presenting objectives to raters? Methods are needed for the determination of the number of objectives required in a program that truly circumscribes the universe of interest. The question of what kind of objectives best communicate curriculum goals requires attention. A balance must be struck between the extremes of utilizing many very specific objectives and a few general objectives in curriculum development.

The development of a system for transforming objectives into instructional opportunities is needed. Just as the amplification of objectives into domain specifications result in test item development, objectives must be amplified into guidelines for planning instructional opportunities.

Too often an implementation has begun before measurement specialists are involved in a project. It is suggested that future projects considering the development of an objectives-based program include measurement specialists in the development stage. This will result in a clarification of desired outcomes and predetermined assessment tasks. More attention should be given to formative assessments that are sensitive to instruction.

The assessment scheme should be designed before program implementation. Research should be done in determining what decisions must be made during an implementation, and in sequencing assessment tasks to complement them.

The question of how many validated items must be used to yield reliable data in different types of tests is a persistent problem. How many items are required to sample an objective in preassessment, formative assessment, retention assessment, and summative assessments?

Item response data are useful in locating flawed items. In this study the item statistics also revealed domain specifications that were too broadly defined. This seems to be a line of research not addressed elsewhere.

Teacher performance directly affects student gains. More research and development must be done on aligning teacher performance with program characteristics and goals. The results of program-related inservice education and supervision must be researched.

This project has attempted to investigate the curriculum and evaluative components of a model for the implementation of objectives-based programs. It was successful to the extent that a basic mathematics curriculum was defined by 96 objectives, from which 96 domain specifications and 960 items were produced. As a result of a series of reviews and revisions 936 items were validated.

A very positive feeling exists among the staff due to their involvement and the confidence they have in the items. However, work remains to be done in completing the steps in building criterion-referenced tests, as described earlier in Chapter III. It is hoped that the remaining steps will be as successful as what has been previously accomplished. This will result in instructionally sensitive tests that will be of assistance to teachers in making decisions concerning students' instructional placement, needs, and mastery in basic mathematics.

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Appendix A

96 Mathematics Objectives

Numeration

Third Grade Skill Objectives

3.15) Given a whole number less than twenty-five the student will be able to select the set of all factors.

3.16) Given three whole numbers from 0-999, the student will be able to select the rearrangement of these numbers in their ascending order of value.

3.17) Given a three-digit whole number, the student will be able to identify the digit corresponding to a specific place value.

Fourth Grade Skill Objectives

4.17) Given a whole number from 0-100,000, the student will be able to identify its expanded form.

4.18) Given three whole numbers from 1,000-99,999 the student will be able to select the rearrangement of these numbers giving their ascending order of value.

4.19) Given a five-digit whole number the student will be able to identify the digit corresponding to a specific place value.

4.20) Given a verbal problem on any whole number to ten thousand, the student will be able to select that number.

4.21) Given a whole number less than 100, the student will be able to select the set of six whole number factors.

4.22) Given any whole number less than or equal to twenty-five, the student will be able to identify a set of four multiples for that number.

Numeration

Fifth Grade Skill Objectives

5.18) Given three common fractions, the student will be able to select the rearrangement of these fractions, giving them in their ascending order of value.

5.19) Given any positive decimal limited to the hundredths place, the student will be able to identify that number in expanded form.

5.20) Given three whole numbers from 100,000 to 1,000,000, the student will be able to arrange them in their ascending order of value.

5.21) Given a nine-digit whole number, the student will be able to identify the digit corresponding to a specific place value.

5.22) Given a verbal decimal problem to the thousandths place, the student will be able to select the correct numerical equivalent.

5.23) Given three natural numbers less than one-hundred, the student will be able to select their least common multiple.

5.24) Given three natural numbers less than one-hundred, the student will be able to select their greatest common factor.

5.25) Given any whole number from two to one-hundred, the student will be able to express the prime factors of that number.

Numeration

Sixth Grade Skill Objectives

6.20) Given any positive decimal limited to the ten-thousandths place, the student will be able to identify that number in expanded form.

6.21) Given a seven-digit decimal with no more than three digits to the right of the decimal point, the student will be able to identify the digit corresponding to a specific place value.

Rational Numbers

Third Grade Skill Objectives

3.10) Given a diagram of a circle, rectangle or a square subdivided into two to nine congruent sections with at least one section shaded, the student will be able to select the fractions describing the shaded portion.

3.11) Given two proper one-digit fractions, the student will indicate whether they are equal or are not equal.

3.12) Given a pictorial representation of a set of objects having a cardinal number to 24, the student will be able to identify a fractional part of it.

3.13) Given any proper fractions, the student will be able to select the correct verbal expression.

3.14) Given any problem on finding fractional parts of a set, the student will be able to solve it.

Rational Numbers

Third Grade Skill Objectives

3.10) Given a diagram of a circle, rectangle or a square subdivided into two to nine congruent sections with at least one section shaded, the student will be able to select the fractions describing the shaded portion.

3.11) Given two proper one-digit fractions, the student will indicate whether they are equal or are not equal.

3.12) Given a pictorial representation of a set of objects having a cardinal number to 24, the student will be able to identify a fractional part of it.

3.13) Given any proper fractions, the student will be able to select the correct verbal expression.

3.14) Given any problem on finding fractional parts of a set, the student will be able to solve it.

Rational Numbers

Fourth Grade Skill Objectives

4.12A) Given any common fraction, the student will be able to select the alternative expressing the fraction in lowest terms.

4.12B) Given a set of congruent objects having a cardinal number from 15-100, the student will be able to identify the pictorially represented proper fraction.

4.13) Given two proper fractions, the student will be able to compare them.

4.14A) Given a mixed number and a pictorial representation of it, the student will be able to write an improper fraction.

4.14B) Given a mixed number, the student will be able to select its equivalent improper fraction.

4.15A) Given a pictorial representation of an improper fraction, the student will be able to write the equivalent mixed number which will not be reduced to lowest terms.

4.15B) Given an improper fraction the student will be able to select the mixed number which names the same number in lowest terms.

4.16) Given a visual representation of equivalent fractions, the student will be able to select the correct equation showing the two fractional numerals that tell what part of the set is shaded.

Rational Numbers

Fifth Grade Skill Objectives

5.14) Given a point and a letter on a number line, the student will be able to name the number as a common fraction or as a mixed number.

5.15) Given a common fraction, the student will be able to select the alternative which expresses that fraction in lowest terms.

5.15) Given two different common fractions, both having the same numerator or denominator, but not both, the student will be able to select the fraction representing the greater value.

5.17) Given three common fractions, the student will be able to select their least common denominator.

Rational Numbers

Sixth Grade Skill Objectives

6.11A) Given any open sentence involving Whole Numbers and Rational Numbers in Fractional Form, the student will be able to use the Distributive Property of Multiplication Over Addition to find the missing element.

6.11B) Given any open sentence involving only Rational Numbers In Fractional Form, the student will be able to use the Distributive Property of Multiplication Over Addition to find the missing element.

6.12) Given a simple one or two-digit decimal, the student will be able to find its equivalent common fraction in lowest terms.

6.13) Given a common fraction whose denominator must be a natural number having only factors of two or five, the student will be able to select its finite decimal equivalent.

6.14) Given a common fraction, the student will be able to find its decimal equivalent.

6.15) Given any Rational Number in Fractional Form, the student will be able to select its reciprocal, which will yield a product of one.

6.16) Given the Commutative Property Of Addition For Rational Numbers, the student will be able to supply the missing term.

6.17) Given the Associative Property Of Addition For Rational Numbers, the student will be able to supply the missing term.

6.18) Given the Commutative Property Of Multiplication For Rational Numbers, the student will be able to supply the missing term.

6.19) Given the Associative Property Of Multiplication For Rational Numbers, the student will be able to supply the missing term.

Elementary Operations

Third Grade Skill Objective

3.01) Given two one-digit whole numbers, the student will be able to find the sum.

3.02) Given two one-digit whole numbers, the student will be able to find the difference.

3.03) Given two factors from zero to ten, the student will be able to find the product.

3.04) Given an addition open sentence, the student will be able to use the Commutative Property of Addition to determine the missing addend.

3.05) Given an addition open sentence, the student will be able to use the Associative Property of Addition to determine the missing addend.

3.06) Given two or three whole numbers, the student will be able to find the sum with regrouping.

3.07) Given two two-digit or three-digit whole numbers, the student will be able to find the difference. Regrouping will be involved in either the tens or hundreds column, but not in both columns.

3.08) Given any addition problem involving two proper fractions with like denominators, the student will be able to find the sum.

3.09) Given a division problem involving a one-digit divisor and a quotient represented by a one-digit numeral without a remainder, the student will be able to solve it.

Elementary Operations

Fourth Grade Skill Objectives

4.01) Given two or three whole numbers, the student will be able to find the sum.

4.02) Given an open addition sentence, the student will be able to use the Commutative Property of Addition to determine the missing addend.

4.03) Given an open sentence involving three addends, the student will be able to find the missing addend using the Associative Property of Addition.

4.04) Given two, three or four-digit whole numbers, the student will be able to subtract the smaller from the larger with regrouping.

4.05) Given an open sentence containing only whole numbers, the student will be able to use the Distributive Property of Multiplication Over Addition to find the missing element.

4.06) Given two factors from zero to twelve, the student will be able to name the product.

4.07) Given a multiplication problem involving a three-digit whole number multiplied by a one-digit whole number, the student will be able to find the product.

4.08) Given a whole number factor, and a product not to exceed 144, the student will be able to find the missing factor.

4.09) Given a division problem involving a three-digit dividend and a one-digit divisor, the student will be able to find the quotient.

4.10) Given the Commutative Property of Multiplication, the student will be able to find the missing factor.

4.11) Given the Associative Property of Multiplication, the student will be able to find the missing factor.

Elementary Operations

Fifth Grade Skill Objectives

5.01) Given three to five four-digit numbers, the student will be able to find the sum.

5.02) Given three decimals to the hundredths place, the student will be able to find the sum.

5.03) Given two decimals to the hundredths place, the student will be able to find the difference.

5.04) Given the Commutative Property Of Addition For Three-Digit Whole Numbers, the student will be able to supply the missing term.

5.05) Given the Associative Property Of Addition For Three-Digit Whole Numbers, the student will be able to supply the missing term.

5.06) Given the Commutative Property Of Multiplication For Two- or Three-Digit Whole Numbers, the student will be able to supply the missing term.

5.07) Given the Associative Property Of Multiplication For Two-Digit Whole Numbers, the student will be able to supply the missing term.

5.08) Given the standard multiplication algorithm, the student will be able to multiply a three-digit whole number by a two-digit whole number.

5.09) Given a five-digit dividend, the student will be able to divide using a two-digit divisor and naming the quotient and remainder.

Elementary Operations Cont.

Fifth Grade Skill Objectives Cont.

5.10) Given two proper fractions having unlike denominators, the student will be able to find the sum reduced to lowest terms.

5.11A) Given two proper fractions with unlike denominators, the student will be able to find their difference without reducing to lowest terms.

5.11B) Given two proper fractions with unlike denominators, the student will be able to find their difference reduced to lowest terms.

5.12) Given two proper fractions, the student will be able to compute the product reduced to lowest terms.

5.13) Given an open sentence involving two-digit whole numbers, the student will be able to use the Distributive Property of Multiplication Over Addition to find the missing element.

Elementary Operations Cont.

Sixth Grade Skill Objectives Cont.

6.07B) Given an addition problem involving two simple mixed numbers, the student will be able to find the sum with regrouping in both the whole number and fraction.

6.08A) Given a subtraction problem involving two simple mixed numbers, the student will be able to find the difference without regrouping.

6.08B) Given a subtraction problem involving two simple mixed numbers, the student will be able to find the difference with regrouping.

6.09) Given a multiplication problem involving two simple mixed numbers, the student will be able to find the product.

6.10A) Given any pair of integers having like signs, the student will be able to find the sum.

6.10B) Given a pair of integers having unlike signs, the student will be able to find the sum.

Elementary Operations

Sixth Grade Skill Objectives

6.01) Given three to five whole numbers to the hundred-thousands place, the student will be able to compute the sum.

6.02) Given any addition problem involving three decimals to the ten-thousandths place, the student will be able to find the sum

6.03A) Given any subtraction problem involving whole numbers to the hundred-thousands place, the student will be able to find the difference with regrouping in at least four columns.

6.03B) Given any horizontally-aligned subtraction problem involving whole numbers to the ten-thousands place, the student will be able to find the difference with regrouping in at least three columns.

6.04A) Given any two rational numbers in decimal form to the ten-thousandths place, the student will be able to find the difference.

6.04B) Given any two rational numbers in decimal form to the ten-thousandths place, the student will be able to find the difference with regrouping.

6.05A) Given the standard multiplication algorithm, the student will be able to multiply two three-digit whole numbers.

6.05B) Given any two rational numbers in decimal form limited to two places to the right of the decimal point, the student will be able to find the product.

6.06) Given a division problem involving a two-digit decimal divisor and a two to five digit decimal dividend, the student will be able to find the quotient.

6.07A) Given an addition problem involving two simple mixed numbers, the student will be able to find the sum with whole number regrouping.

Appendix B

Domain Specification Summary Review

Domain Specification Summary Review

Domain Specification # _______ Teachers: _______________________

____

____

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Skill Section

Test Directions

Multiple Choice Format

Sample Item

Number of Choices

Vocabulary

Content Comments

Response Comments

Appendix C

Sample Test Booklet
(Form 4.2)

Form - 4.2

4.03.15

1. (342 + 77) + 95 = 342 + (__ + 95)

   a) 514   c) 419

   b) 437   d) 77

2. (437 + 34) + 93 = 437 + (__ + 93)

   a) 34   c) 530

   b) 471   d) 564

3. (334 + 88) + 43 = 334 + (__ + 43)

   a) 465   c) 377

   b) 422   d) 88

4. (478 + 32) + 35 = 478 + (__ + 35)

   a) 32   c) 513

   b) 510   d) 545

5. (561 + 23) + 64 = 561 + (__ + 64)

   a) 648   c) 584

   b) 625   d) 23

4.01.60

6. 979 + 77 + 340 =

   a) 1,386   c) 1,496

   b) 1,396   d) 2,089

7. 492 + 403 + 66 =

   a) 1,555   c) 961

   b) 1,061   d) 951

8. 505 + 780 + 55 =

   a) 1,330   c) 1,440

   b) 1,340   d) 1,835

9. 847 + 44 + 908 =

   a) 1,789   c) 1,899

   b) 1,799   d) 2,195

10. 249 + 88 + 809 =

   a) 1,938   c) 1,136

   b) 1,146   d) 1,046

4.06.60	4.08.15
11. $8 \times 8 =$ a) 0 c) 64 b) 16 d) 65	16. $8 \times$ ____ $= 64$ a) 7 c) 9 b) 8 d) 10
12. $12 \times 6 =$ a) 73 c) 18 b) 72 d) 6	17. $7 \times$ ____ $= 28$ a) 6 c) 4 b) 5 d) 3
13. $12 \times 5 =$ a) 60 c) 17 b) 59 d) 7	18. $6 \times$ ____ $= 42$ a) 7 c) 5 b) 6 d) 4
14. $9 \times 4 =$ a) 5 c) 35 b) 13 d) 36	19. $9 \times$ ____ $= 72$ a) 5 c) 7 b) 6 d) 8
15. $7 \times 7 =$ a) 50 c) 14 b) 49 d) 0	20. $5 \times$ ____ $= 45$ a) 9 c) 7 b) 8 d) 6

4.10.60

21. $57 \times 9 = 9 \times$ ____

a) 9 c) 66

b) 57 d) 513

22. $86 \times 7 = 7 \times$ ____

a) 7 c) 93

b) 86 d) 602

23. $38 \times 7 = 7 \times$ ____

a) 266 c) 38

b) 45 d) 7

24. $243 \times 13 = 13 \times$ ____

a) 3,159 c) 243

b) 256 d) 13

25. $768 \times 42 = 42 \times$ ____

a) 32,256 c) 768

b) 810 d) 42

4.22.60

26. Which of the following set of numbers gives the multiples of 20?

a) 1, 2, 4, 5

b) 5, 10, 20, 40

c) 10, 20, 40, 60

d) 20, 40, 60, 80

27. Which of the following set of numbers gives the multiples of 25?

a) 25, 50, 75, 100

b) 5, 25, 50, 75

c) 1, 5, 25, 50

d) 1, 5, 25

28. Which of the following set of numbers gives the multiples of 16?

a) 1, 2, 4, 8

b) 4, 8, 16, 32

c) 8, 16, 32, 48

d) 16, 32, 48, 64

29. Which of the following set of numbers gives the multiples of 18?

a) 18, 36, 54, 72

b) 6, 18, 36, 54

c) 3, 6, 18, 36

d) 1, 2, 3, 6

30. Which of the following set of numbers gives the multiples of 24?

a) 2, 4, 6, 12

b) 6, 12, 24, 48

c) 12, 24, 48, 72

d) 24, 48, 72, 96

4.14B60	4.15B60
31. $4\frac{9}{12}$ is equal to: a) $\frac{13}{12}$ c) $\frac{13}{4}$. b) $\frac{25}{12}$ d) $\frac{57}{12}$	36. $\frac{11}{4}$ is equal to: a) $\frac{4}{11}$ c) $6\ \frac{3}{4}$ b) $2\ \frac{3}{4}$ d) $10\ \frac{3}{4}$
32. $7\ \frac{3}{9}$ is equal to: a) $\frac{66}{9}$ c) $\frac{10}{7}$ b) $\frac{19}{9}$ d) $\frac{10}{9}$	37. $\frac{9}{8}$ is equal to: a) $9\ \frac{1}{8}$ c) $1\ \frac{1}{8}$ b) $1\ \frac{1}{4}$ d) $\frac{8}{9}$
33. $9\ \frac{4}{11}$ is equal to: a) $\frac{13}{11}$ c) $\frac{24}{11}$ b) $\frac{13}{9}$ d) $\frac{103}{11}$	38. $\frac{9}{6}$ is equal to: a) $\frac{6}{9}$ c) $3\ \frac{1}{2}$ b) $1\ \frac{1}{2}$ d) $9\ \frac{1}{2}$
34. $8\ \frac{3}{4}$ is equal to: a) $\frac{35}{4}$ c) $\frac{11}{4}$ b) $\frac{15}{4}$ d) $\frac{11}{8}$	39. $\frac{11}{7}$ is equal to: a) $11\ \frac{4}{7}$ c) $1\ \frac{4}{7}$ b) $4\ \frac{4}{7}$ d) $\frac{7}{11}$
35. $9\ \frac{4}{10}$ is equal to: a) $\frac{13}{10}$ c) $\frac{23}{10}$ b) $\frac{13}{9}$ d) $\frac{94}{10}$	40. $\frac{12}{9}$ is equal to: a) $\frac{3}{4}$ c) $3\ \frac{1}{3}$ b) $1\ \frac{1}{3}$ d) $12\ \frac{1}{9}$

4.17.60

41. Which expanded number equals: 97,687?

a) 9,000 + 7,000 + 6 + 80 + 700

b) 9,000 + 7,000 + 600 + 80 + 7

c) 90,000 + 7,000 + 6 + 80 + 700

d) 90,000 + 7,000 + 600 + 80 + 7

42. Which expanded number equals: 68,765?

a) 60,000 + 8,000 + 700 + 60 + 5

b) 60,000 + 8,000 + 7 + 60 + 5

c) 6,000 + 8,000 + 700 + 60 + 5

d) 6,000 + 8,000 + 7 + 60 + 5

43. Which expanded number equals: 87,654?

a) 8,000 + 7,000 + 6 + 50 + 400

b) 8,000 + 7,000 + 600 + 50 + 4

c) 80,000 + 7,000 + 6 + 50 + 400

d) 80,000 + 7,000 + 600 + 50 + 4

44. Which expanded number equals: 56,259?

a) 50,000 + 6,000 + 200 + 50 + 9

b) 50,000 + 6,000 + 2 + 50 + 9

c) 5,000 + 6,000 + 200 + 50 + 9

d) 5,000 + 6,000 + 2 + 50 + 9

45. Which expanded number equals: 84,589?

a) 8,000 + 4,000 + 5 + 80 + 900

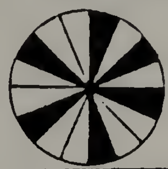
b) 8,000 + 4,000 + 500 + 80 + 9

c) 80,000 + 4,000 + 5 + 80 + 900

d) 80,000 + 4,000 + 500 + 80 + 9

4.16.60

46. Choose the equation representing the fractional part of the region which is shaded.



a) $\frac{16}{6} = \frac{8}{3}$ c) $\frac{6}{10} = \frac{3}{5}$

b) $\frac{10}{16} = \frac{5}{8}$ d) $\frac{6}{16} = \frac{3}{8}$

47. Choose the equation representing the fractional part of the region which is shaded.

a) $\frac{3}{12} = \frac{1}{4}$ c) $\frac{9}{12} = \frac{3}{4}$

b) $\frac{3}{9} = \frac{1}{3}$ d) $\frac{12}{3} = \frac{4}{1}$

48. Choose the equation representing the fractional part of the region which is shaded.

a) $\frac{18}{10} = \frac{9}{5}$ c) $\frac{10}{18} = \frac{5}{9}$

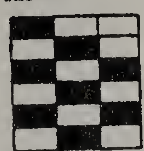
b) $\frac{10}{8} = \frac{5}{4}$ d) $\frac{8}{18} = \frac{4}{9}$

49. Choose the equation representing the fractional part of the region which is shaded.

a) $\frac{6}{16} = \frac{3}{8}$ c) $\frac{16}{10} = \frac{8}{5}$

b) $\frac{10}{16} = \frac{5}{8}$ d) $\frac{10}{6} = \frac{5}{3}$

50. Choose the equation representing the fractional part of the region which is shaded.

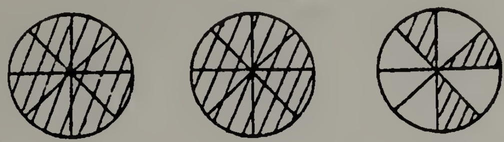


a) $\frac{18}{8} = \frac{9}{4}$ c) $\frac{10}{18} = \frac{5}{9}$

b) $\frac{8}{10} = \frac{4}{5}$ d) $\frac{8}{18} = \frac{4}{9}$

4.14A15

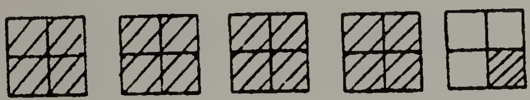
51. The fraction for $2\frac{3}{8}$ is:



a) $\frac{19}{3}$ c) $\frac{8}{19}$

d) $\frac{19}{8}$ d) $\frac{3}{[illegible]}$

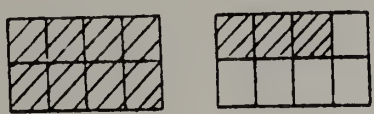
52. The fraction for $4\frac{1}{4}$ is:



a) $\frac{17}{4}$ c) $\frac{5}{4}$

b) $\frac{17}{4}$ d) $\frac{4}{17}$

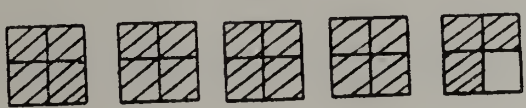
53. The fraction for $1\frac{3}{8}$ is:



a) $\frac{11}{2}$ c) $\frac{8}{11}$

b) $\frac{11}{8}$ d) $\frac{3}{8}$

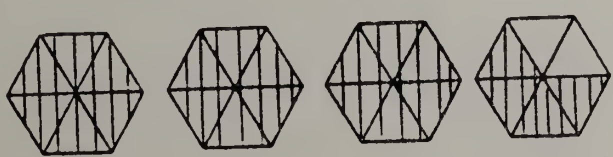
54. The fraction for $4\frac{3}{4}$ is:



a) $\frac{19}{4}$ c) $\frac{5}{4}$

b) $\frac{19}{5}$ d) $\frac{4}{19}$

55. The fraction for $3\frac{4}{6}$ is:



a) $\frac{22}{4}$ c) $\frac{4}{5}$

b) $\frac{22}{6}$ d) $\frac{6}{22}$

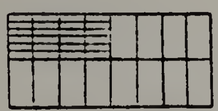
4.16.15

56. Choose the equation representing the fractional part of the region which is shaded.

a) $\frac{2}{8} = \frac{1}{4}$ c) $\frac{6}{2} = \frac{3}{1}$

b) $\frac{6}{8} = \frac{3}{4}$ d) $\frac{8}{6} = \frac{4}{3}$

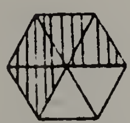
57. Choose the equation representing the fractional part of the region which is shaded.



a) $\frac{16}{4} = \frac{4}{1}$ c) $\frac{4}{12} = \frac{1}{3}$

b) $\frac{12}{16} = \frac{3}{4}$ d) $\frac{4}{16} = \frac{1}{4}$

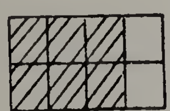
58. Choose the equation representing the fractional part of the region which is shaded.



a) $\frac{4}{2} = \frac{2}{1}$ c) $\frac{4}{6} = \frac{2}{3}$

b) $\frac{6}{4} = \frac{3}{2}$ d) $\frac{2}{6} = \frac{1}{3}$

59. Choose the equation representing the fractional part of the region which is shaded.



a) $\frac{2}{8} = \frac{1}{4}$ c) $\frac{6}{2} = \frac{3}{1}$

b) $\frac{6}{8} = \frac{3}{4}$ d) $\frac{8}{6} = \frac{4}{3}$

60. Choose the equation representing the fractional part of the region which is shaded.

a) $\frac{4}{12} = \frac{1}{3}$ c) $\frac{8}{12} = \frac{2}{3}$

b) $\frac{4}{8} = \frac{1}{2}$ d) $\frac{12}{4} = \frac{3}{1}$

4.21.15

61. Which set contains all the factors of 100?

a) 100, 200, 300, 400, 500

b) 1, 2, 5, 10, 20, 25, 50, 100

c) 1, 2, 4, 5, 10, 20, 25, 50, 100

d) 1, 2, 4, 5, 10, 15, 20, 25, 50, 100

62. Which set contains all the factors of 56?

a) 1, 2, 4, 6, 7, 8, 14, 28, 56

b) 1, 2, 4, 7, 8, 14, 28, 56

c) 1, 2, 4, 8, 14, 28, 56

d) 56, 112, 168, 224, 280, 336

63. Which set contains all the factors of 18?

a) 1, 2, 3, 4, 6, 8, 10, 12, 24

b) 1, 2, 3, 4, 6, 8, 12, 24

c) 1, 2, 4, 6, 8, 12, 24

d) 24, 48, 72, 96, 120, 144

64. Which set contains all the factors of 18?

a) 18, 36, 54, 72, 90, 108

b) 1, 2, 6, 9, 18

c) 1, 2, 3, 6, 9, 18

d) 1, 2, 3, 4, 6, 9, 18

65. Which set contains all the factors of 64?

a) 1, 2, 4, 8, 12, 16, 32, 64

b) 1, 2, 4, 8, 16, 32, 64

c) 1, 2, 4, 8, 32, 64

d) 64, 128, 192, 256

Appendix D

Background Sheet for Principals

Math Testing

Date of Testing: Week of May 5th

Purpose: The primary goals of the math testing program are:

1. Evaluate 3rd through 6th grade growth on a basic set of math objectives and,

2. Monitor all 3rd - 6th grade students' mastery and determine strengths and weaknesses.

Background: Recent N.Y.S. Education Department mandates require the identification of students who require supplemental mathematics instruction. The test being developed in Islip is criterion-referenced. This is an alternative to norm-referenced testing because it yields better information for instructional decision making.

All 3rd - 6th grade teachers at Sherwood contributed their time and talent to the development of the items. They;

- selected objectives they considered "basic" to their grade level,
- reviewed the rules of generating items from objectives, and
- reviewed the items developed for each objective.

The Task: This the next step in the procedure for developing validated tests is to validate the items. This requires the administration of each item to a minimum of seventy students. Therefore each student in grades 3-6 in all the elementary schools will be given a test. In order to make this quick and clean the items have been separated in four test forms per grade requiring only about an hour of testing. This is not a test of student performance; it is a test of item performance. This process is central to developing a "pool" of validated items from which valid and reliable tests can be generated.

Other Information:

1. Mrs. Karen Joyce (Wing & Sherwood), Mrs. Morrissey (Commack) will coordinate all aspects of the testing with the classroom teachers.

2. All the teachers will have to do is administrate the tests and collect them for the coordinators.

3. Mrs. Joyce and Mrs. Morrissey will test all absentees.

4. No information on students will be returned because this is a test of the items not students.

5. Teachers will be given more information at a later date.

6. These objectives are considered a minimum - basic - set which we would expect almost all elementary students to master by the end of sixth grade.

   They are not a total elementary math program. Think of them as the lower limit.

Grade	Number of items each test
3	40 or 45
4	60 or 65
5	55 or 60
6	60